[ESTABLISHED 1832]
THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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J. S. BONSALL, Vice-President and General Manager
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Editors:
E. A. AVERILL. R. H. ROGERS

V. C. JONES, Western Representative
407 Medinah Bldg., Chicago

JUNE, 1911

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While the Mallet is a success as it stands, its complete development and perfection depends largely upon the automatic stoker and in this appliance the past year has shown wonderful progress. Several designs of stokers have reached the position where they can safely be called successful, although of course not perfectly successful. They will fire a locomotive under average conditions with excellent results and reasonable reliability. The development of this appliance has been one of the most gratifying features of the year's progress.

Experiments during the year seem to have very largely settled all doubts concerning the value of superheating and the indications are that this practice is going to exceed, in its advantages, even the predictions of its strongest champions. The article by Mr. Hoffman, in another part of this issue, clearly shows the popularity the superheater has attained, mostly during the past few months. The year has also quite largely settled the controversy over high and low degree superheat, and it has been the high degree superheater which has made the greater progress. Recent experience also seems to indicate that the superheater is going to be a very strong ally of the Mallet.

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ticularly striking, but so far it is not clear that the claims made by the champions of this system can be entirely substantiated under railroad conditions. There seems to be but little doubt that the continued improvement in shop methods will be along the lines of scientific management, the same as they would have been irrespective of the recent general publicity given to the subject. This agitation may hasten the development along these lines in some cases, but it is hoped that it will not hasten it beyond a natural pace or to the defeat of the ultimate benefits which can be obtained if properly handled. Scientific management can be installed in manufacturing plants in many cases, but experience indicates that it must develop in the railroad shop. This development can be hastened, but must not be forced.

THE IMPORTANCE OF CENTRAL CONTROL IN MACHINE TOOL DESIGN

The high development of the modern machine tool necessarily imposes complication in varying degrees, but despite this feature the fact remains strikingly prominent that ease of control is present to a marked degree in practically all of them. Many examples of foreign built machine tools exhibit a very poor conception of the importance which should be associated with centralized control, but it is a point which has apparently been accorded the full measure of recognition and consideration by American designers.

That this is as it should be requires no comment. An operator should not be compelled to walk around even a large machine once in the day's run, except possibly to oil it, and this latter is now being provided for by automatic and continuous systems of lubrication. A machine tool in addition to being rigid and powerful must be handy. It is the means to an end which is not simply the removal of so many pounds of cuttings per hour, but it is the production of a finished article in the shortest possible time. The "handiness" of a machine is relatively of more importance now when using high speed machines than in the days of carbon steel. It is a feature not difficult to secure in the instance of the smaller tools, but in large slotting, milling and planing machines many problems need to be solved before all of the levers and stops can be placed directly in reach of the operator.

Too much importance cannot be given to the necessity of grouping the various handles and levers which control or produce the different motions, of the means for effecting quick changes of speed, direction and changing of feed; in fact, anything which will conduce to ease in manipulation and the saving of time. It is in these features especially that the American tools excel, and the successful tools of the future will undoubtedly be those where handiness is combined with the necessary elements of stability, strength and power.

MANUFACTURING BY RAILROADS

The discussion of the railway as a manufacturer, which was featured last month during the annual convention of the Railway Storekeepers' Association, revives a question which is in reality as far now from solution as it was when first propounded. We know little more in regard to the desirability of making things ordinarily purchased than we ever did, and the prominent plants where this procedure is resorted to are quite reticent in the production of statistics attesting to its value.

The two most prominent illustrations probably in the world of wholesale manufacture by railroads may be found in the instance of the Crewe shops of the London and North-Western Railway, and those of the Philadelphia and Reading, at Reading, Pa. In the former anything used by any department of the railroad, from rails to flags, soap and writing paper, is turned out on the premises. The Reading is less ambitious in scope, but may well be likened as the nearest American counterpart. Those who advocate this procedure from an economical standpoint frequently refer to Crewe in support of their arguments, but obviously without full information of its existing conditions. Economy is not the particular consideration, and it is not a claim of the London and North-Western that any is secured by this production of ordinarily purchased items.

These shops are very old, practically the oldest in England. They were in existence long before the present development in outside manufacturing plants had been attained, and it was necessary that they should provide for their own needs. For instance, in the comparatively recent period which marked the introduction of the steel casting, the supply was not forthcoming, hence the addition to Crewe of a steel foundry. The entire situation is merely an illustration of growth or expansion imposed by certain conditions, and now that the latter no longer exist it is freely admitted by mechanical engineers in England that the London and North-Western cost of production is higher than the terms of the business concerns from which they would buy, in the case of a very large number of articles. The fact is also, of course, apparent that the company is denied the advantages of competition which would ensue to a certain extent if they became buyers in the open market. Crewe is a poor illustration of an advantageous railroad manufacturing scheme. There is no good reason why it should go on making things simply because it started to do so years ago.

The real facts in connection with the latter as relates to our own roads are that the experiences of those who have attempted manufacturing have been widely diversified. It is recalled that the Baltimore and Ohio about ten years ago installed a complete spring plant in its Mt. Clare shop in Baltimore, with very indifferent results, while on the other hand the Chicago and Northwestern, for instance, makes and repairs all springs for the 1,700 locomotives on the system. There does not seem to be much to be learned from such contrasts, and the above is only an illustration of innumerable instances.

A careful review of the past few years would seemingly indicate that the large majority of railroads are decidedly favoring the purchase of material. It is fully realized that they cannot compete with the progressive ideas and equipment of the regular manufacturers. The manufacturing field, divided as it is, concentrates its business and employs experts, not only as foremen, but also as workmen. The manufacturer must pay attention to all lines of economy, this being demanded by competition which will eliminate him if he does not do so. It is much easier for a railroad shop to drop back or stand still in the manufacturing field than for the manufacturer who is spurred on by competition or necessity. All railroads have specifications covering given lines of material and it is easier to compel a manufacturer to live up to these than for the railroad to compel its own men to do so.

In regard to the manufacturing of such articles as tinware, piston packing, locomotive springs, crank pins, etc., it is generally conceded by railroad officials that the railroad shop cannot compete with the concerns who make a specialty of manufacturing such materials. This may be readily explained through the presence in these manufacturing plants of highly developed special machines and appliances which are operated by much less highly compensated labor than that employed by railroads for similar work.

On the other hand, conditions undoubtedly arise on railroads from time to time when the question of manufacture needs to be accorded serious consideration. During a period of depression, known to be temporary, manufacturing may be very sensibly resorted to, even at a loss, in order to prevent the dissolution or weakening of a well balanced, smooth working shop organization.

It would appear, however, that practical economy is better secured through purchasing, and only such miscellaneous material of which no great amount is required should be manufactured. The general subject is very broad and significant, and it is well worthy of the attention which it now receives.

Test of Mallet Locomotives

NORFOLK AND WESTERN RAILWAY.

THE VERY CAREFUL AND ACCURATE COMPARATIVE ROAD TESTS RECENTLY MADE ON TWO DISTINCTLY DIFFERENT ARRANGEMENTS OF THE SAME POWER LOCOMOTIVES AFFORD SOME VERY INTERESTING AND VALUABLE INFORMATION IN CONNECTION WITH THE FEATURES OF DESIGN OF THIS COMPARATIVELY UNFAMILIAR TYPE

In May and June, 1910, there were received by the Norfolk & Western Railway Company five Mallet compound locomotives of the 2-8-8-2 type, which were given the class designation of Y1, and five similar locomotives of the 0-8-8-0 type, which were given the class designation of X1.* These two designs of locomotives, while differing in many of the features, have the same sized cylinders, the same steam pressure, the same diameter of driving wheels, and in fact were both designed to deliver the same power under the same conditions.

Shortly after they were received arrangements were made for conducting a thorough comparative test and for this purpose the Westinghouse Air Brake Company's dynamometer car No. 5 was procured and used. These tests were carried out with the greatest care and accuracy, as will be seen by referring to the methods used, which are described at the end of this article, and the results obtained are most important in indicating the feature of advantage found in both designs.

As a general summary of the conclusions it is stated in a report to the superintendent of motive power:

"Engine No. 998 (2-8-8-2 type) gives a better boiler performance up to the time the steam passes from the high pressure cylinders, where there is evidence of a considerable drop in steam pressure from the high pressure steam exhaust to the low pressure steam delivery. This drop in pressure is remarkably in excess of that observed on engine No. 993 (0-8-8-0 type). As to engine performance we find that engine No. 993 handled 9.8 per cent. more cars and 3.6 per cent. more tonnage at an increase of 19 per cent. in speed. The consumption of coal per thousand ton miles on the two engines was very close, with a slight difference in favor of engine No. 993. The indicated and draw bar horse power, as well as the per cent. of draw bar to indicated horse power were all singularly favorable to engine No. 993. We can draw no other conclusion from this data than that engine No. 993 (0-8-8-0 type) shows the better performance of the two types of Mallet compounds."

The following table gives the general dimensions, weights and ratios of the two locomotives tested:

	998	993
GENERAL DATA.		
Locomotive	998	993
Fuel	Bit. coal	Bit. coal
Tractive effort	77,000 lbs.	85,000 lbs.
Weight in working order	390,000 lbs.	375,000 lbs.
Weight on drivers	360,000 lbs.	375,000 lbs.
Weight on leading truck, est.	15,000 lbs.	
Weight on trailing truck, est.	15,000 lbs.	
Wt. of engine and tender in working order	560,000 lbs.	433,600 lbs.
Wheel base, total	55 ft. 6 in.	41 ft. 2 in.
Wheel base, engine and tender	83 ft. 3 in.	72 ft. 10 in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.67	4.42
Total weight ÷ tractive effort	5.06	4.42
Tractive effort × diam. drivers ÷ heating surface	730.00	887.00
Total heating surface ÷ grate area	78.50	71.00
Firebox heating surface ÷ total heating surface, %	3.55	3.95
Weight on drivers ÷ total heating surface	61.00	69.70
Total weight ÷ total heating surface	66.00	69.70
Volume both cylinders, cu. ft.	25.50	25.50
Total heating surface ÷ vol. cylinders	233.00	210.00
Grate area ÷ vol. cylinders	2.96	2.96
CYLINDERS.		
Kind	Compound	Mellin Compound
Diameter	24½ and 39 in.	24½ and 39 in.
Stroke	30 in.	30 in.
VALVES.		
Kind	Piston	Piston
Diameter	15 in.	14 in.
Lead	¼ in.	3/16 in.
WHEELS.		
Driving, diameter over tires	56 in.	56 in.
Driving, thickness of tires	3 in.	3 in.
Driving journals, main, diameter and length	10 x 12 in.	10 x 12 in.
Driving journals, others, diam. and length	9½ x 12 in.	9½ x 12 in.
Engine truck wheels, diameter	30 in.	
Engine truck, journals	6 x 10 in.	
Trailing truck wheels, diameter	30 in.	
Trailing truck, journals	6 x 10 in.	
BOILER.		
Style	Straight	Straight
Working pressure	200 lbs.	200 lbs.
Nozzle, diameter	7 in. ¾ in. Br'd'g.	6 in. ⅜ in. Br'd'g
Outside diameter of first ring	80 in.	83⅞ in.
Firebox, length and width	120⅛ x 90¼ in.	120⅛ x 98¼ in.
Firebox plates, thickness	⅜ and ½ in.	⅜ & ½ in.
Firebox, water space	F. 5½, S. & B. 5 in.	F. 5½ in. S. & B. 5 in.
Tubes, number and outside diameter	350—2¼ in.	367—2¼ in.
Tubes, length	21 ft.	24 ft.
Heating surface, tubes	4,309 sq. ft.	5,167 sq. ft.
Heating surface, firebox	210 sq. ft.	212 sq. ft.
Heating surface, feedwater heater	1,389 sq. ft.	
Heating surface, total	5,908 sq. ft.	5,379 sq. ft.
Reheater heating surface	586 sq. ft.	
Grate area	75.2 sq. ft.	75.3 sq. ft.
TENDER.		
Water capacity	9,000 gals.	9,000 gals.
Coal capacity	14 tons	14 tons

In the following table is given a summary of the average results of six trips on each locomotive, showing the percentage in favor of either design:

SUMMARY OF AVERAGE RESULTS.

	No. 998.	No. 993.	Per cent. in favor of 998.	Per cent. in favor of 993.
Boiler pressure pounds per sq. in.	191.3	193.2		
Water supplied boiler, pounds	108,450.0	97,582.0		
Coal total, pounds	12,617.0	12,467.0		
Ratio total water to total coal	8.66	7.83	11.0	
Equivalent evaporation per sq. ft. heating surface per hour	8.42	9.70		15.2
Equivalent evaporation per pound of coal.	10.46	9.49	10.0	
Coal per sq. ft. of grate area per hr.	61.20	72.40		18.
Moisture in steam high pressure (per cent.).	.94	.83		13.2
Moisture in steam low pressure (per cent.).	1.10	2.02	83.7	
Draft in front end of smoke box (in. of water).	6.1	7.2		18.
Temperature of escaping gases F. deg.	376.1	514.2	37.0	
Drop in steam press. between high and low press. cyl's (L. side)	9.2	4.9		46.9
Boiler horsepower	1,439.0	1,515.0		5.2
Boiler efficiency, general	77.1	64.9	18.8	
Distance of run miles per trip	29.5	29.7		
No. of cars in train, average per trip	20.5	22.5		9.8
Tonnage of train, average per trip	1,458.7	1,511.6		3.6
Engine performance, speed miles per hour	11.0	13.1		19.0
Pounds of coal per M ton miles excel. delays and ewight of engine and tender	278.1	273.7		1.6
Indicated horsepower.	1,397.7	1,604.3		14.8
Draw bar horsepower	1,093.7	1,347.0		23.2
Per cent. of draw bar to indicated horsepower	78.2	83.9		7.2

A study of the complete data given below indicates the following features in connection with various parts of the test:

General Performance.—Engine No. 993 shows 15 per cent. reduction in running time, with a 19 per cent. increase in speed, hauling 9.8 per cent. more cars and 3.6 per cent. more tonnage, with a reduction of 1.6 per cent. in coal per thousand ton-miles.

Draft and Temperature of Gases.—The average smoke box vacuum on engine No. 993 is greater by 18 per cent., resulting from a smaller nozzle. There is also an increase in coal consumption per square foot of grate area per hour of 18 per cent. on this locomotive. The presence of the feed water heater and re-heater tubes in engine No. 998 have a marked effect upon the temperature of the escaping gases, there being a difference of 37 per cent. in favor of engine No. 998 on this account.

The Value of Steam Re-Heater.—The temperatures of steam before and after entering the re-heater on engine No. 998 did not indicate any marked advantage in this arrangement, as the temperature was lower than it was before passing through the re-heater. The drop in temperature is no doubt due to the increased volume of the heater and the steam entering was accompanied by a drop in pressure and temperature. That the re-heater has a drying influence on the steam is indicated by the low percentage of moisture in the steam delivered to the low-pressure cylinder of engine No. 998.

Equivalent Evaporation.—The equivalent evaporation per pound of coal shows up well for both engines, and while the results appear high at first glance, it must be remembered that these are very large boilers and the low temperature of escaping gases would indicate a very high evaporative efficiency When compared with the results obtained on the testing plant at St. Louis it will be seen that these figures are not excessive.

* For fully illustrated description of these locomotives see the AMERICAN ENGINEER as follows:
Class Y1, July, 1910, page 269.
Class X1, September, 1910, page 341.

Pressures from Indicator Cards.—Referring to the initial pressures on the low-pressure cylinders with the least back pressure of the high-pressure cylinders, it will be seen that the left low-pressure cylinder of engine No. 998 gives an average of 53.6, while the least back pressure on the left high-pressure cylinders is 62.65, showing a drop of 9.2 lbs. between the high and low-pressure cylinders. The same figures on engine No. 993 show a drop of 4.9 lbs. between the high and low-pressure cylinders, or 46.7 per cent. less. This difference is doubtless due to the friction and increased volume of the numerous passages through the re-heater on engine No. 998.

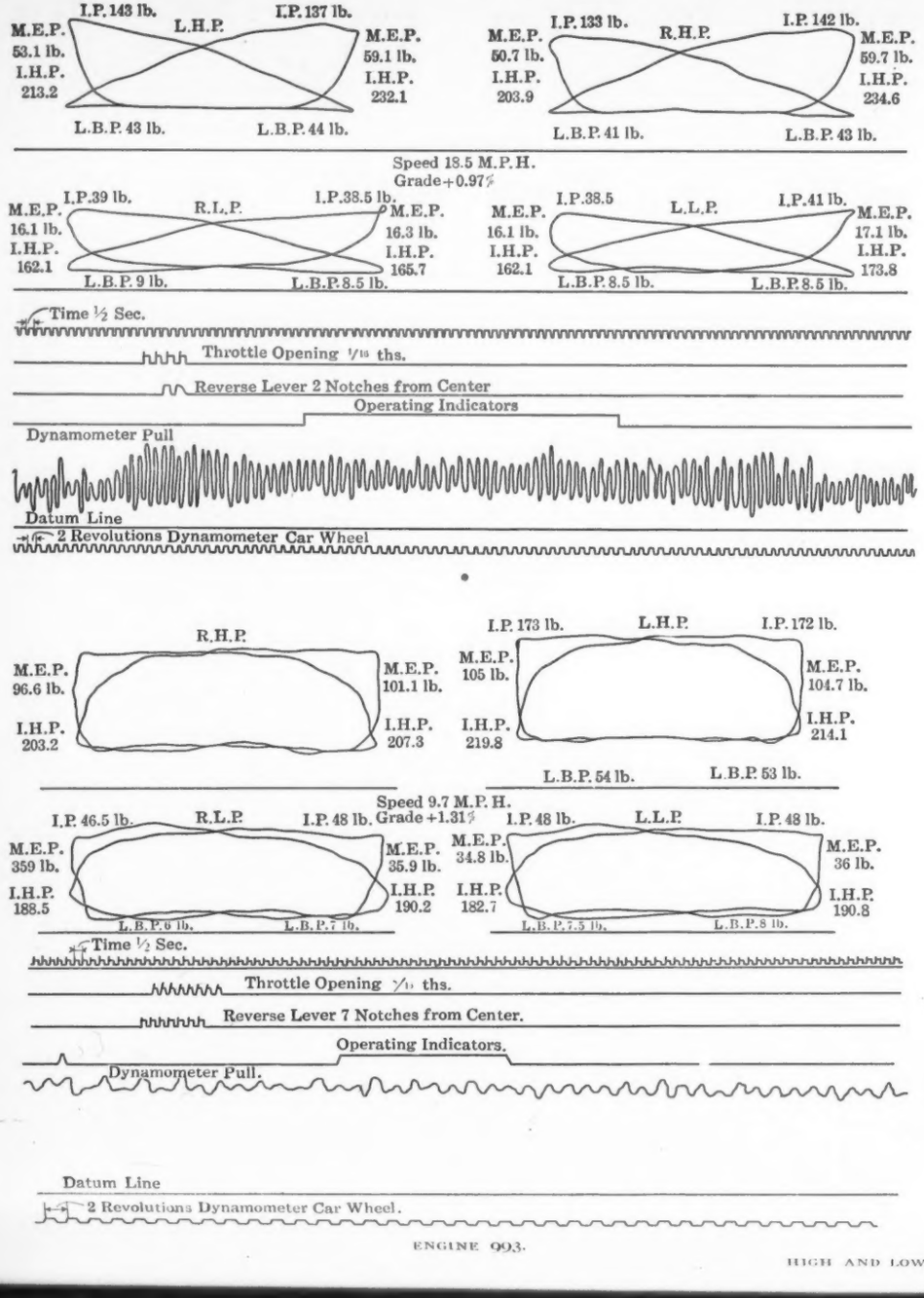
Horse Power.—Engine No. 998 gave an average indicated horse power of 1,397.7, with a corresponding draw bar horse power of 1,093.7, or 78.2 per cent. Engine No. 993 gave 1,604.3 indicated horse power and a draw bar horse power of 1,347.7, or 83.9 per cent. In indicated horse power, No. 993 was greater by 14.8 per cent. and in draw bar horse power this engine was 23.2 per cent. greater. The boiler horse power of No. 998 is slightly lower than No. 993, but its efficiency is 18.8 per cent. greater.

High and Low Speed Conditions.—On the section of the road from Roanoke to Elliston engine No. 998 gave an average speed of 15.1 miles per hour and No. 993 18.2 miles per hour. Under these conditions engine No. 998 gave a draw bar horse power equivalent to 72.2 per cent. of the indicated horse power, while No. 993 gave 79 per cent. of the indicated horse power, a difference in its favor of 6.8 per cent. The detailed record shows that Engine No. 993 gave an average minimum speed which very closely approached the average maximum of 998, while at the same time it was handling 9.8 per cent. more cars and 3.6 per cent. more tonnage.

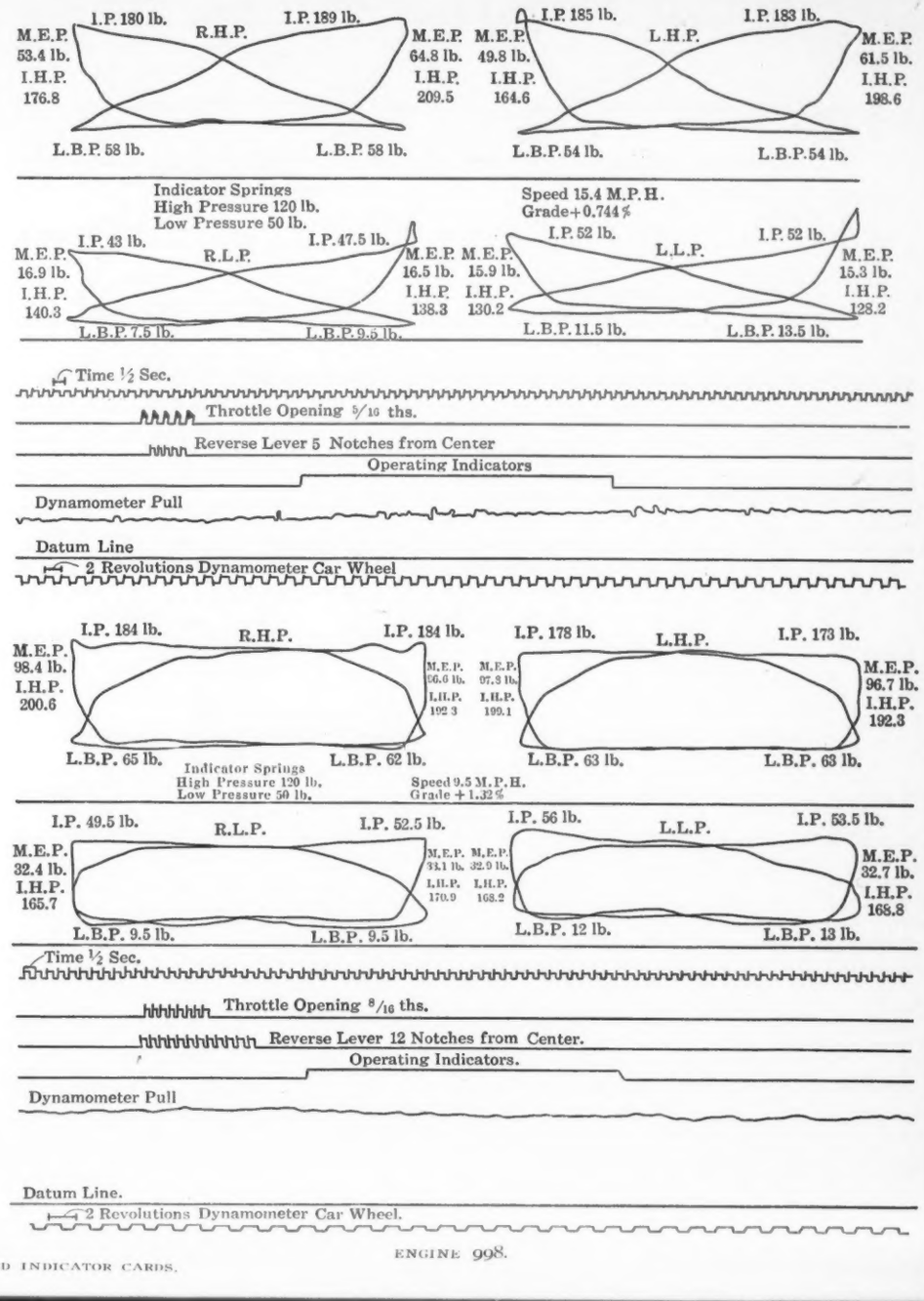
On the section of the road from Elliston to Christiansburg there is a steady pull up a 1.32 per cent. grade for a distance of approximately 12 miles. The average speed of No. 998 with these conditions was 8.3 miles per hour, while No. 993 gave 9.4 miles per hour. In this service No. 998 gave a draw bar horse power of 80.7 per cent. of the indicated and No. 993 gave 85.5 per cent. of the indicated horse power, a difference of 4.8 per cent. greater, which shows that engine No. 998 more nearly approaches the performance of No. 993 when working under slow speed and heavy tonnage conditions.

In the following table giving the full data of the tests, each result is the average of six trips:

GENERAL PERFORMANCE.		
Engine No.	998	993
Type	2-8-8-2	0-8-8-0
Duration of Test, Hours:		
Total	3.663	3.146
Delay	.996	.88
Running	2.667	2.266
Miles run	29.5	29.74
Speed M. P. H.	11.06	13.12
Train tonnage	1,458.7	1,511.6
Number cars	20.5	22.5
Thousand ton miles	43.046	44.955
Pounds of coal per thousand ton miles	278.1	273.7
FUEL, RATE OF COMBUSTION, DRAFTS, TEMPERATURE OF GASES.		
Fuel in pounds:		
Total fired	12,617	12,467
Running fired	11,967	12,300
Fired per hour:		
Total time	3,597	3,967
Running time	4,597	5,436
Rate of combustion per hour:		
Sq. ft. grate area	61.29	72.47
Sq. ft. heating surface	.7799	1.0089
Draft in. of water:		
Smoke box	6.12	7.24
Fire box	2.09	2.19
Temperature of escaping gases:		
Front smoke box	376.1	514.2
Combustion chamber	599.4	.....
Back of baffle plate	.....	527.0
Back of reheater	463.8	.....
Coal by analysis:		
Volatile matter	16.85	17.18
Fired carbon	74.5	77.3
Ash	8.65	5.52
B. T. U.	13,824	14,311
Pounds per hour:		
Coal	4,597	5,436
Per sq. ft. grate area	61.29	72.47
WATER AND STEAM.		
Pounds of water, total:		
Supplied to injector	109,175	98,133
Injector to overflow	725	551
Supplied to boiler	108,540	97,582
Temperature of feed water	68.35	60.3
Pounds of steam per hour, running time:		
Moist steam by boiler	41.134	43,126
Pumps and calorimeter	3,024	2,606
Pop discharge	5,024	1,936
To cylinder	33,085	38,584
Per sq. ft. heating surface	7.0	8.0
Temperature of water leaving reheater	235.6	.....
PRESSURE, QUALITY, PRESSURE AND TEMPERATURE AT REHEATER.		
Pressure pounds per sq. in.:		
Boiler	191.3	193.2
High Pressure delivery	167.8	165.2
Low pressure delivery	54.9	48.3
Quality of steam, per cent. moisture:		
High pressure delivery	.943	.83
Low pressure delivery	1.108	2.02
Temperature of Steam:		
Entering reheater	306.94	
Leaving reheater	301.53	
Degree reheat	—5.41	
Pressure steam:		
Entering reheater	59.29	
Leaving reheater	54.9	
EQUIVALENT EVAPORATION.		
Ratio total coal to total water	8.666	7.83
Equivalent evaporation from and at 212 degs. F.:		
Total	130,880	118,276
Per hour:		
Total	49,643	52,270
Per sq. ft. heating surface	8.4211	9.70
Per pound of coal	10.46	9.49
INITIAL PRESSURE FROM INDICATOR CARDS.		
Initial pressure pounds per sq. in.		
High pressure cylinder.		
Right side.		
H. E.	177.5	.....
C. E.	177.9	.....
Left side.		
H. E.	174.4	162.7
C. E.	176.5	161.3
Low pressure cylinder.		
Right side.		
H. E.	51.9	45.7
C. E.	49.3	45.5
Left side.		
H. E.	52.9	45.4
C. E.	53.4	45.5
BACK PRESSURE FROM INDICATOR CARDS.		
Back pressure pounds per sq. in.:		
High pressure cylinder.		
Right side.		
H. E.	64.9	
C. E.	63.1	
Left side.		
H. E.	62.9	50.6
C. E.	62.8	50.1
Low pressure cylinder.		
Right side.		
H. E.	10.64	8.7
C. E.	10.06	8.34
Left side.		
H. E.	14.24	9.05
C. E.	13.32	8.88
MEAN EFFECTIVE PRESSURE.		
High pressure cylinder.		
Right side.		
H. E.	84.9	89.5
C. E.	86.1	93.1
Left side.		
H. E.	84.4	95.1
C. E.	87.8	96.0
Low pressure cylinder.		
Right side.		
H. E.	29.1	30.2
C. E.	28.9	30.0
Left side.		
H. E.	28.4	30.2
C. E.	29.2	29.5
INDICATED HORSEPOWER.		
High pressure cylinder.		
Right side.		
H. E.	188.8	215.3
C. E.	189.1	220.3
Left side.		
H. E.	186.5	228.2
C. E.	192.7	226.1
Low pressure cylinder.		
Right side.		
H. E.	161.5	180.9
C. E.	160.3	177.7
Left side.		
H. E.	157.6	180.9
C. E.	161.2	174.9
DISTRIBUTION OF POWER.		
Indicated horsepower.		
Right side.		
High Pressure	377.9	435.6
Low pressure	321.8	358.6
Left side.		
High pressure	379.2	454.3
Low pressure	318.8	355.8
Total.		
Right side	699.7	794.2
Left side	698.0	810.1
All cylinders	1,397.7	1,604.3
Cylinders:		
High pressure	757.1	889.9
Low pressure	640.6	714.4
Ratio of high to low pressure	1.18	1.25
HORSEPOWER—EFFICIENCY.		
Indicated horsepower:		
High pressure cylinders	757.1	889.9
Low pressure cylinders	640.6	714.4
All cylinders	1,397.7	1,604.3
Draw bar pull, lbs.	40,363	46,021
Draw bar h. p.	1,093.7	1,347.0
Boiler h. p.	1,439	1,515
Boiler efficiency	77.1	64.9
HORSEPOWER RELATION.		
Horsepower:		
Indicated:		
Per sq. ft. heating surface	.237	.298
Per sq. ft. grate area	18.6	21.4
Drawbar:		
Per sq. ft. heating surface	.186	.250



ENGINE 993.



ENGINE 998.

HIGH AND LOW SPEED INDICATOR CARDS.

Per sq. ft. grate area	14.6	18.0
Boiler at dome	1,439	1,515
POUNDS OF STEAM THROUGH CYLINDERS PER THOUSAND TON MILES.		
Per thousand ton miles including weights of engine and tender	43.046	44.955
Per thousand ton miles excluding weights of engine and tender	50.802	52.429
Water through cylinders—pounds:		
Per thousand ton miles excluding weight of engine and tender	2,020	1,943
Per thousand ton miles including weight of engine and tender	1,711	1,665
Total	86,890	87,273
B. T. U. through cylinder per thousand ton miles including weights of engine and tender	2,050,900	1,996,331
HORSEPOWER.		
Speed M. P. H.	11.06	13.12
Indicated horsepower:		
High pressure cylinders	757.1	889.9
Low pressure cylinders	640.6	714.4
Total I. H. P.	1,397.7	1,604.3
Drawbar pull, pounds	40,363	46,021
Drawbar H. P.	1,093.7	1,347
Ratio I. H. P. to drawbar H. P.	1.28	1.19

The carefulness and accuracy with which the tests were made is well illustrated by the description of the methods used, given below:

COAL MEASUREMENT.

In determining the amount of coal used on this test the coal was sacked, 100 pounds to the sack, and was emptied on the fuel deck to the fireman according to his requirements. An effort was made to have a nice, clean, uniform fire at the beginning of each trip and to burn the fire down approximately to the same condition at the end of each trip. Coal used during delays was accounted for separately.

WATER MEASUREMENTS.

The tank used in connection with this test was carefully calibrated, gauge boards being used at each corner of the tank, and hose was connected both at the front and rear, by having a glass tube in the end of the hose and holding it against the gauge boards, the amount of water at all four corners of the tank could be accurately determined; these determinations were made at the beginning and end of the test, as well as before and after taking water en route. The initial and final water observations were made with the engine standing on the same track elevation. The water in the boiler was marked on the gauge glass before starting and before the final measurements from the tank were taken at the end of each trip; the boiler was filled to the same point as before. The elevation of the boiler was determined by the use of a level, which determined this feature accurately.

The water losses were taken into consideration, the injector overflow was collected and measured; the steam consumed by the air pumps was indicated by stroke counters connected to both pumps, which gave a basis for calculation; the loss through calorimeters was also noted and necessary corrections made. In accounting for the loss through the pops, the pop casings were drilled and tapped and plugs with a 1/16 in. diameter orifice were screwed in flush with the inside of the casing; these plugs were then connected to a pipe line running back to a condensing coil in the tank, by this scheme a small per cent. of the steam discharged through the pops passed through these orifices and was condensed and collected in a small tank arranged for this purpose. With the engine stationary, and the boiler full of water, engine was fired to keep the pops up until the height of the water in the boiler receded to the bottom of the gauge glass. The injectors were then put on and the boiler filled to the original point. With the use of the calibrated tank, we were then able to determine the amount of water required to fill the boiler which corresponded with the amount discharged through the pops. The ratio of the water discharged through the pop to the water collected from the condenser gave us the desired percentage for determining the pop loss on each trip.

PRESSURE DETERMINATIONS.

All steam pressure determinations were indicated by ordinary steam gauges, which were carefully and repeatedly tested to assure their accuracy; this refers both to the steam pressure gauge on the boiler as well as the steam gauges used in connection with the calorimeters. The atmospheric pressure was determined by use of a marine type barometer which was mounted in the dynamometer car. This instrument was broken on account of running over a derail switch, and only two days' observations were made.

DRAFT DETERMINATIONS.

The draft was shown by open water manometer tubes, one manometer being connected to a line running to the front end; the other was connected to a short pipe which was inserted through the fire door when these readings were taken.

QUALITY OF STEAM.

The quality of steam was determined by using Peabody throttling calorimeters; one of these was attached to the high pressure delivery pipe and the other connected with the steam chest on the low pressure cylinder.

THROTTLE AND REVERSE BAR POSITIONS.

The reverse bar quadrant was stenciled, counting the notches from the center. The throttle opening was determined by taking the dome cap off and marking the valve stem in the cab in increments of 1/16 open. The throttle was accurately adjusted to increments of ⅛ open and the necessary points located on the throttle stem. The position of reverse bar and throttle were registered on the dynamometer chart by operating push buttons in the locomotive cab—one push on the reverse bar button indicating the bar one notch from center: one push on the throttle button indicating the throttle 1/16 open.

THE NICKELIZED CHILLED CAR WHEEL

Nickel and chrome are the most extensively used of all alloys to improve the quality of steel, and a method has now been found to employ them to the same advantage in a chilled wheel mixture. This process, which has been developed by the Nickel-Chrome Chilled Car Wheel Company,* affords one of the greatest improvements that has been made in a chilled car wheel mixture in fifty years, and the results of a recent series of tests made by the Pennsylvania Railroad Company at Altoona, indicate that a very important element of safety has been introduced into railroad practice, with a much increased mileage from the wheel.

The following comparison of a nickelized chilled wheel with a very superior standard wheel, under the M. C. B. drop test, proves that both the elastic limit and the freedom from shrinkage strain were greatly in favor of the former. In this test a 200-pound weight was used, on a 12-foot fall, the requirement being 12 blows.

Nickelized.

305th Blow, small crack developed through core holes
330th, Crack developed
355th, 2nd Crack through tread
359th, Piece broken out of wheel

Standard.

141st Blow, crack through flange across plate
250th, Crack developed
310th, Another crack across tread
319th, Piece broken out of tread

As showing greater resiliency, the nickelized wheel did not begin to crack until the 305th blow, while the standard began to give way at the 141st blow. These wheels were remarkably alike chemically, embodying:

.58 Silicon, in the nickelized.
.60 Silicon, in the standard.

Incidentally the drop test showed also that the nickelized wheel was not on so great a shrinkage strain, it being claimed for the nickel alloy that it has a lower co-efficient of expansion than any other alloy known.

In the service tests which were conducted in connection with the heaviest mountain traffic in the country, one hundred and fifty-six 33-in. nickelized chilled car wheels were put under Berwick 100,000 lb. coal cars. After 12 months, during which one wheel, still running, made 29,966 miles, nine wheels only were withdrawn for defects, showing less than 6 per cent. of the wheels drawn. As the railroads of the country draw on an average 30 per cent. of the car wheels they use every year, only 6 per cent. is a remarkable showing for a first trial, and it may be further enhanced by the fact that no wheel broke in service. Eighty-eight 36-in. nickelized wheels were also tested under locomotive tenders in the same territory, and nine were drawn for "comby from brakes or brake burns," and one for worn tread, with a mileage of 21,260.

The chemical analysis of the wheels that stood the foregoing mechanical and service tests was ideal:

	Sil.	Sul.	Mang.	Phos.	C. C.	Nickel.
Grey Iron	.442	.131	.467	.343	.78	.687
Chill Tread ...	.441	.110	.483	.342	3.339	.687

In making a nickelized steel car axle, the lowest amount necessary to produce the best results has been fixed at 3½ per cent., or 70 pounds per ton of 2,000 pounds. Owing to the greater amount of combined carbon in a chilled wheel mixture, it is only necessary to use 14 pounds per ton of 2,000 pounds. The present cost of nickel is 38 cents a pound in large quantities. So that $5.32 represents the amount in dollars and cents per ton in a car wheel mixture in the first lot of wheels, but when these are remelted, the new nickel required would only be about $2.25 per ton or seventy-five cents per wheel.

IN 1905 PLATINUM SOLD AS LOW AS $18.50 PER OUNCE, and even at that figure was not in great demand. To-day it is selling for $43.00 per ounce, a truly astonishing figure, when the price of gold, about $22.00 per ounce, is considered. The great increase in the manufacture of incandescent lamps is the principal cause for the advance in price.

* Frick Bldg., Pittsburgh, Pa.

The Street Locomotive Stoker

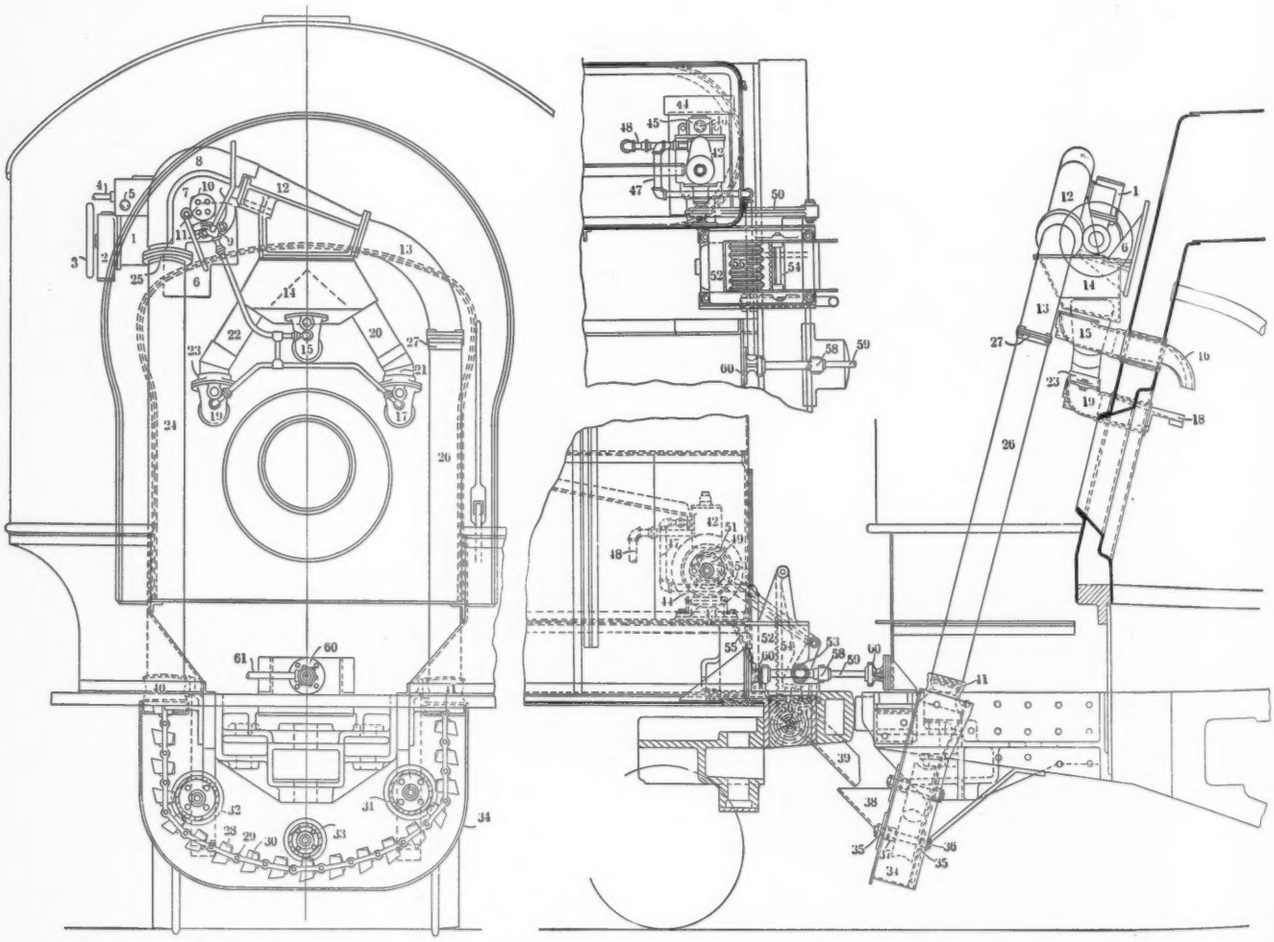
A STOKER FOR LOCOMOTIVES WHICH INCLUDES A CRUSHER, ELEVATOR AND FUEL DISTRIUTING ARRANGEMENT ALL PERMANENTLY ATTACHED TO THE LOCOMOTIVE, WHILE AT THE SAME TIME NOT IN ANY WAY INTERFERING WITH THE USE OF THE FIRE DOOR OR INTERIOR FIREBOX ARRANGEMENT

Guided by the conviction that a locomotive stoker should be part of the locomotive, as distinguished from a portable device, that it should be capable of handling any reasonable amount of fuel of any character with which the engine might be supplied, that it should not in any way interfere with the use of the fire door and that it should carry the minimum possibility of accident and maximum in flexibility of control, Clement F. Street has designed the apparatus shown in the accompanying illustrations, which, during the past two years, has been remarkably successful in operation on both the heaviest type of Mallet freight engines and on high speed freight trains scheduled at passenger train speed.

This stoker has proved itself under these conditions to satisfactorily fulfil all reasonable requirements in connection with handling large quantities of fuel, giving perfect combustion, which means smokeless combustion and in proving its reliability and flexibility while running in pooled service.

The principle on which ths stoker is designed, viz., the steam jet or scatter type, is one which permits the lower grades of fuel to be satisfactorily burned, giving a high combustion efficiency at low fuel cost. It is also one which, because of the constant and steady injection of fuel, maintains a very constant firebox temperature, resulting in a decided decrease in boiler maintenance with its often accompanying engine failures and roundhouse delay.

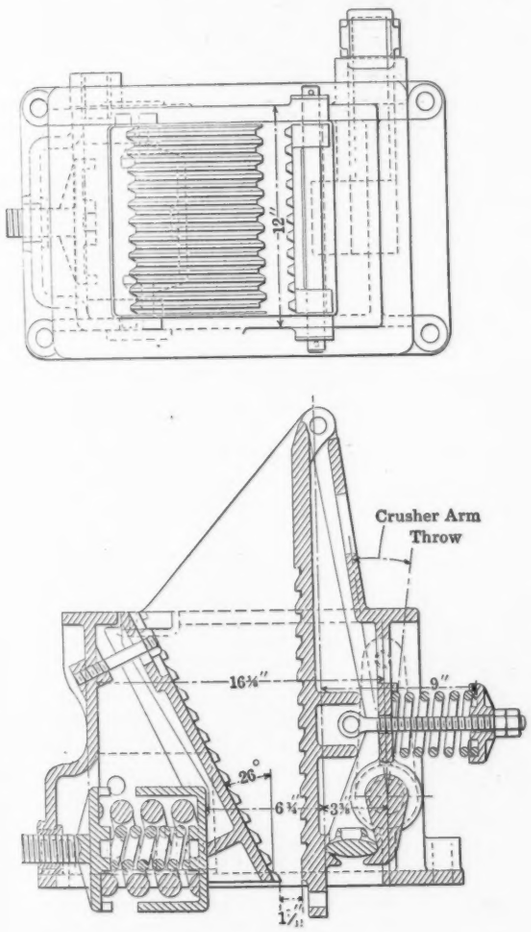
Reference to the illustrations will show that the stoker per-



1. Elevator Engine.
2. Elevator Engine Oil Separator.
3. Elevator Engine Flywheel.
4. Elevator Engine Steam Pipe.
5. Elevator Engine Exhaust Pipe.
6. Elevator Engine Bed Plate.
7. Sprocket Wheel Casing.
8. Sprocket Wheel Casing Cover.
9. Controller.
10. Controller Cam.
11. Controller Lever.
12. Discharge Pipe.
13. Pipe Bend.
14. Distributer Hopper.
15. Center Distributer Elbow.
16. Center Distributer.
17. Right Hand Distributer Elbow.
18. Left Hand Distributer.
19. Left Hand Distributer Elbow.
20. Right Hand Distributer Pipe.
21. Right Hand Distributer Pipe Flange.
22. Left Hand Distributer Pipe.
23. Left Hand Distributer Pipe Flange.
24. 7 in. Elevator Pipe.
25. 7 in. Elevator Pipe Flange.
26. 6 in. Elevator Pipe.
27. 6 in. Elevator Pipe Flange.
28. Elevator Bucket.
29. Elevator Chain.
30. Elevator Chain Link.
31. Lower Hopper Right Hand Sheave.
32. Lower Hopper Left Hand Sheave.
33. Lower Hopper Center Sheave.
34. Lower Hopper.
35. Lower Hopper Sheave Bearing.
36. Lower Hopper Sheave Shaft.
37. Lower Hopper Sheave Collar.
38. Lower Hopper Boot.
39. Coal Chute.
40. 7 in. Bell Mouth.
41. 6 in. Bell Mouth.
42. Crusher Engine.
43. Crusher Engine Bed Plate.
44. Crusher Engine Fly Wheel.
45. Crusher Engine Oil Separator.
46. Crusher Engine Vent.
47. Crusher Engine Steam Pipe.
48. Crusher Engine Exhaust Pipe.
49. Crusher Eccentric.
50. Crusher Eccentric Arm.
51. Crusher Eccentric Arm Cap.
52. Crusher.
53. Crusher Lever.
54. Crusher Swinging Jaw.
55. Crusher Stationary Jaw.
56. Distance Piece.
57. Cam Shaft.
58. Slip Joint Pipe.
59. Ball Joint Body.
60. 1 in. Pipe to Crusher Engine.

forms three distinct operations. First, crushing the coal; second, elevating and conveying; third, distributing and injecting. The crushing apparatus is independent and is located on the tender. It consists of a special design swinging jaw crusher with spring release behind the jaws to prevent breakage of its parts. It is operated by a small Westinghouse single acting engine located inside of the end of one of the tank water legs, which is partitioned off for this purpose. The crusher itself is placed on the left-hand side on a level with the floor of the tender, so that the coal is simply shoved into it, the fireman often using his foot for this purpose. It will handle run of mine coal in lumps 8 x 10 in. and crushes it to a size which will pass through a 1½-in. slot. The crusher operates continuously and requres no attention other than an occasional oiling of the engine bearings. Below the crusher there is a sheet iron trough or chute extending downward at an angle of about 45 degs., which discharges the coal into a hopper located on the bottom of the elevator casing underneath the deck. This hopper is wide enough to allow for the changes in position of the engine and tender.

The elevator consists of a double endlesss chain with specially



CRUSHER USED WITH STREET STOKER.

shaped malleable iron bucket having a capacity of about 34.5 cu. in. This chain travels in a casing made of iron piping of suitable size, being guided at the bottom by three adjustable rollers and driven by specially designed steel sprocket wheel located in the upper left-hand corner, the conveyor operating up on the left-hand side and down on the right. It travels at the rate of about 90 ft. per minute. This driving sprocket, completely encased, is driven through a worm gear by a single acting Westinghouse engine secured to the boiler head just behind it in a position where it offers minimum of obstruction. Below the deck plate the elevator with its guiding rolls is enclosed in a sheet iron casing, protecting it from damage.

The crushed fuel is fed to the elevator buckets through the hopper in the casing and is carried up the left-hand side and after passing over the driving sprocket makes a sharp turn downward and passes through a cylindrical screen. The four quarters of this screen are perforated with holes of different diameters. They are ¼ in., 5/16 in., ⅜ in., and ½ in. By rotating this screen so that one or the other of this set of holes are brought beneath the buckets the quantity of coal passing through can be varied. The fine coal passing through this screen drops into the passage leading to the center nozzle. Beyond the screen the buckets pass over a hopper in which there is a deflector plate that can be adjusted so as to turn more or less coal to the right or left. This deflector plate is arranged so that the rolling of the locomotive does not affect its operation.

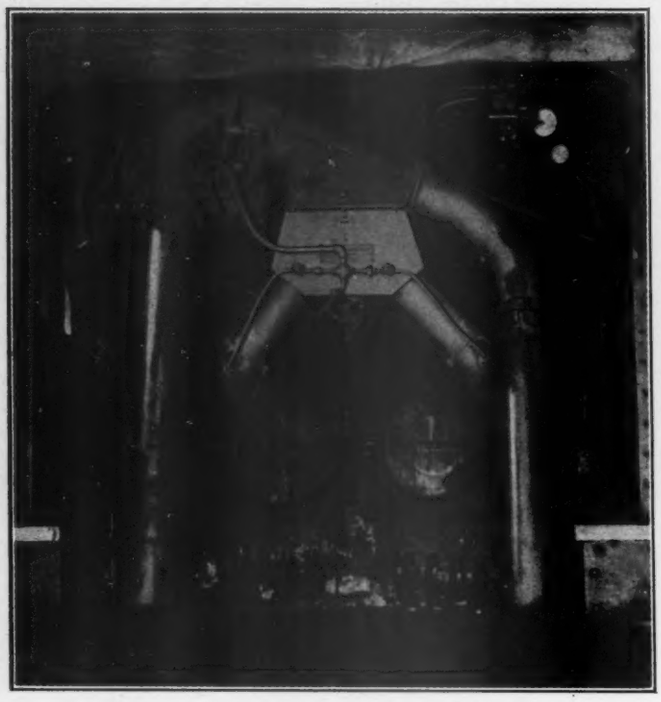
There are three injector nozzles, one being central over the fire door; the other two on the sides lower down. The deflector plate is adjustable and controls the distribution to the outer nozzles and the screen to the center. This scheme makes it possible to easily control the distribution as desired. Reference to the illustrations will show the location of the nozzles and their connection with the elevator system.

Each of the three nozzles are made of cast iron with an elbow outside and pass through large tubes rolled and beaded into the back head of the boiler and firebox sheet. They extend a short distance inside of the firebox and the center one has a downward projection, which directs the fine fuel emerging from it into the back corners and back part of the box, where there is the least tendency to draw it unconsumed into the flues. The side nozzles have an extension which carries a small lip that, while it does not interfere with the coal emerging from the nozzle sufficiently to change its direction, does act as a scattering arrangement and tends to scatter coal over the front end of the box and along the side sheets on either side.

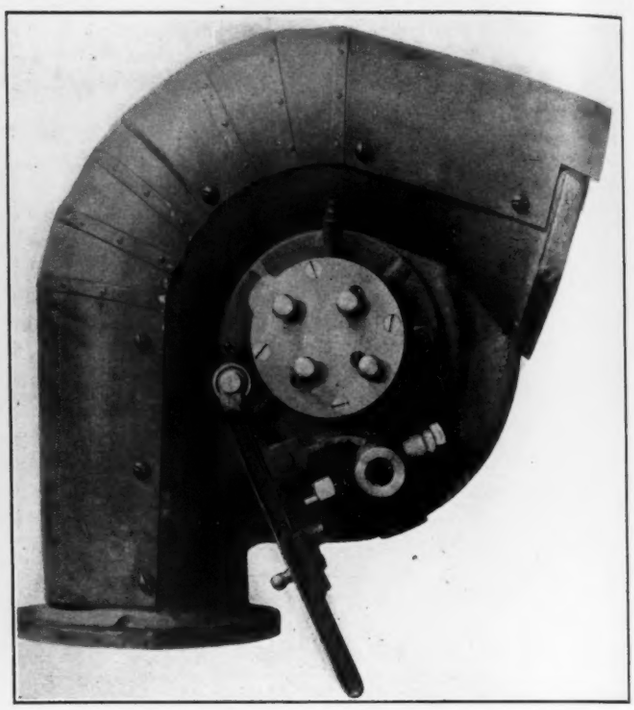
The coal falling down through the distributing system is deposited at the back end of these nozzles just in front of the steam jets, which, acting intermittently, inject it into the firebox. All three steam jets act in unison, being connected to the same steam pipe, which receives its supply direct from the boiler. In this steam line is inserted a spring seated valve, which is secured to the casing enclosing the driving sprocket of the elevating system. The spring of this valve holds it in a closed position and it can only be opened by forcing the projecting stem of the valve inward against the spring. This movement is performed by the latch on the end of the lever centrally hinged, which carries a roller at its upper end. It is provided with a handle on the lower end. The end of the driving sprocket axle extends through the casing and carries a small drum against which the roller on the lever just mentioned has a contact. On the inside of this drum are four cams which can be raised independently and when so raised will come in contact with the roller and put the lever into action, which in turn, if the latch on the lever is in the proper position, will open the spring valve intermittently, allowing a powerful puff of steam to emerge from the nozzles. One or more of these cams are put into operation, depending upon the quantity of fuel that is being handled by the conveyor, which in turn depends upon the amount being put through the crusher. If for any reason it is desired to stop the injection of coal into the firebox while the elevator is still delivering the amount already crushed, the latch on the lever can be dropped down, which closes off the steam supply instantly.

All of this apparatus is rigidly secured to the back head of the boiler and locomotive frames, and while occupying considerable room in the cab it is in such a location as to interfere in no way with the engineer or with the fireman in case it is necessary to hand fire. The fire door opening and connections are entirely unobstructed, permitting the easy inspection of the condition of the fire and the use of a hook if necessary. The apparatus when once started and properly adjusted does not require attention, since the supply of coal being delivered is controlled by the supply put into the crusher.

On the L. S. & M. S. Railway there are several large consolidation locomotives running in the regular pool out of Col-

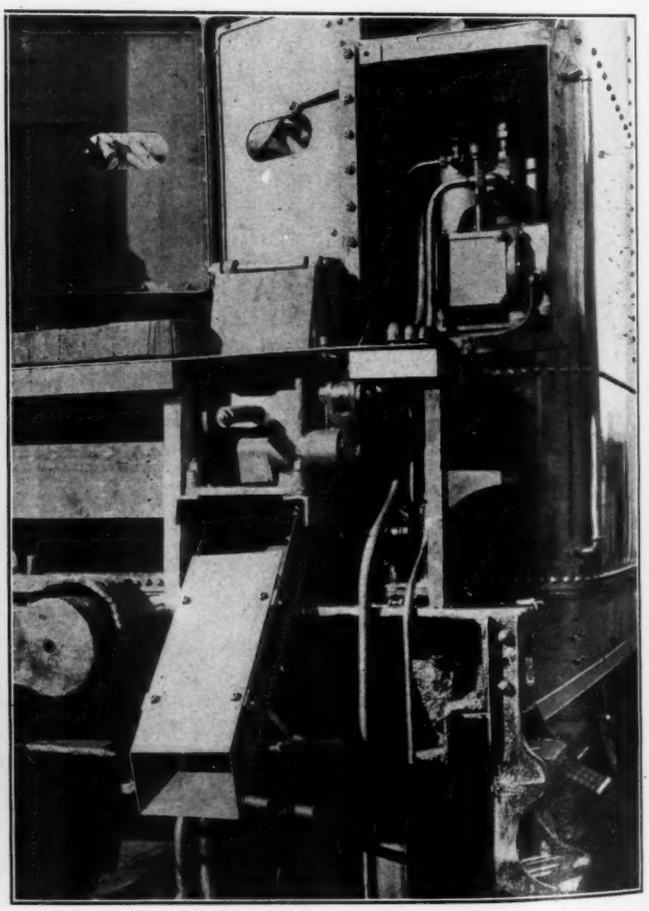


GENERAL VIEW IN CAB OF CONSOLIDATION LOCOMOTIVE EQUIPPED WITH A STREET STOKER.



ARRANGEMENT OF STEAM JET CONTROL OF STREET STOKER.

VIEW SHOWING CASING ENCLOSING ELEVATOR UNDER CAB.



CRUSHER, CRUSHER ENGINE AND CHUTE ON TENDER.

linwood, which are equipped with this stoker, and a recent unheralded visit of a representative of this journal the first locomotive equipped with the stoker that was ordered out was boarded for an inspection trip. This engine was assigned to a fast freight run, was in charge of an engine crew which had had no more service with the stoker engine than other crews of the same pool. The locomotive, a large consolidation, was forced practically to its capacity and the ease with which the

DRIVING SPROCKET AND DETAIL OF ELEVATOR.

steam pressure was maintained without variation was remarkable. In the firebox the fuel bed was level, incandescent and thin, being in practically perfect condition. The box was filled with an incandescent flame to a much greater extent than is obtained under hand firing conditions, showing that a large part of the fine fuel was consumed in suspension. The stack showed only a moderate amount of smoke for short intervals, emitting practically no smoke for most of the time.

This design of stoker was applied and has been operating most successfully for several months on the large Mallet compound locomotive which was illustrated on page 136 of the April, 1910, issue of this journal. It has also been applied to engines of the same type on a number of other roads.

PENNSYLVANIA RAILROAD TO RETAIN JERSEY CITY TERMINAL.—On account of the various rumors that the Pennsylvania Railroad is about to dispose of its Jersey City terminals, Samuel Rea, first vice-president of the company, has stated that there is no foundation in the report. While the road's main passenger station is now in Manhattan, and, with the inauguration of the joint service with the Hudson Company between Park Place, Newark, the Manhattan Transfer and the Hudson Terminal at Church and Cortlandt streets, few passenger trains in addition to express and mail trains will run to Jersey City, the station there is one of the most valuable railroad company terminals on the New York harbor, and its continued use for railroad purposes is assured. The Lehigh Valley uses the terminal for all its passenger service and will continue to do so, as far as anybody is prophesying.

IT WAS IN THE YEAR 1875 that the first railroad was opened in Japan connecting Tokio and Yokohama. Since then new lines have been completed in many directions, and it is now possible to travel from the extreme south to the northern boundary—a distance of more than a thousand miles.

A REPORT FROM AN AMERICAN CONSULAR OFFICER in a Latin-American country states that the managements of two railroads in his district are installing grease cups on all locomotives on their lines, and as yet have been unable to find a grease that is hard enough to stand the climate.

A NEW STYLE TRUCK-LEVER CONNECTION

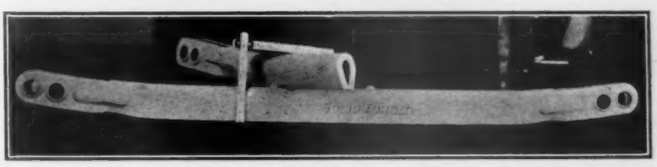
There has recently been placed upon the market a truck-lever connection of a design embodying remarkable strength with both simplicity and novelty. In the past various styles of truck-lever connections or bottom rods have been used, made either from wrought, round iron with welded ends, or the jaw material drawn down to round to the required length with one welding in the middle. There is also the malleable iron bar and the combination of malleable jaws and other material.

The new detail here illustrated is made from open-hearth bar steel of ½ in. thickness. In the process of manufacture the bars are cold sheared to correct length, the jaws are re-enforced, material forming part of the pin holes being pushed out to give the added bearing surface for an M. C. B. pin, after which the entire bar is hot-pressed into its inverted U shape and closed at the bottom as shown in the illustration.

When considering the truck-lever connection in its relation to the other details forming the brake rigging, it should be borne in mind that, with the exception of the push rod, this connection is the only member which is subjected to a compression load, and when, in addition to this fact there is a more or less eccentric loading due to offset or even slightly crooked bars, it should be apparent that the material in this new connection is placed far more efficiently for a compression load. A maximum of material in the outer fibers of the bar with a corresponding increase in depth and width of section and a decrease in the weight as compared to the solid round bar, forms an ideal column section to resist compression loading.

Briefly, the principal superior features of this design of truck-lever connection may be thus enumerated:

No welded joints; correct distribution of material for compression load and corresponding greater factor of safety over



NEW TRUCK-LEVER CONNECTION OF INCREASED STRENGTH.

solid round due to greater depth and width of section; open hearth steel instead of wrought iron; homogeneous material throughout entire bar, and uniformity in manufacture and material of all bars.

During the development of this detail a series of tests were made first to determine the most efficient sections, and secondly to find the strength of this connection in direct comparison with other round, welded bars. The Pittsburgh Testing Laboratory performed all these tests on an Olsen testing machine of 200,000 pound capacity. The bars were supported in a manner imitating service conditions, and, without going into the detail of these numerous test results, it is of interest here to note that in comparison with the welded type of bar, all salient dimensions being the same for the two bars, the solid forged connection developed from 60 to 440 per cent. greater compressive strength than the welded connection.

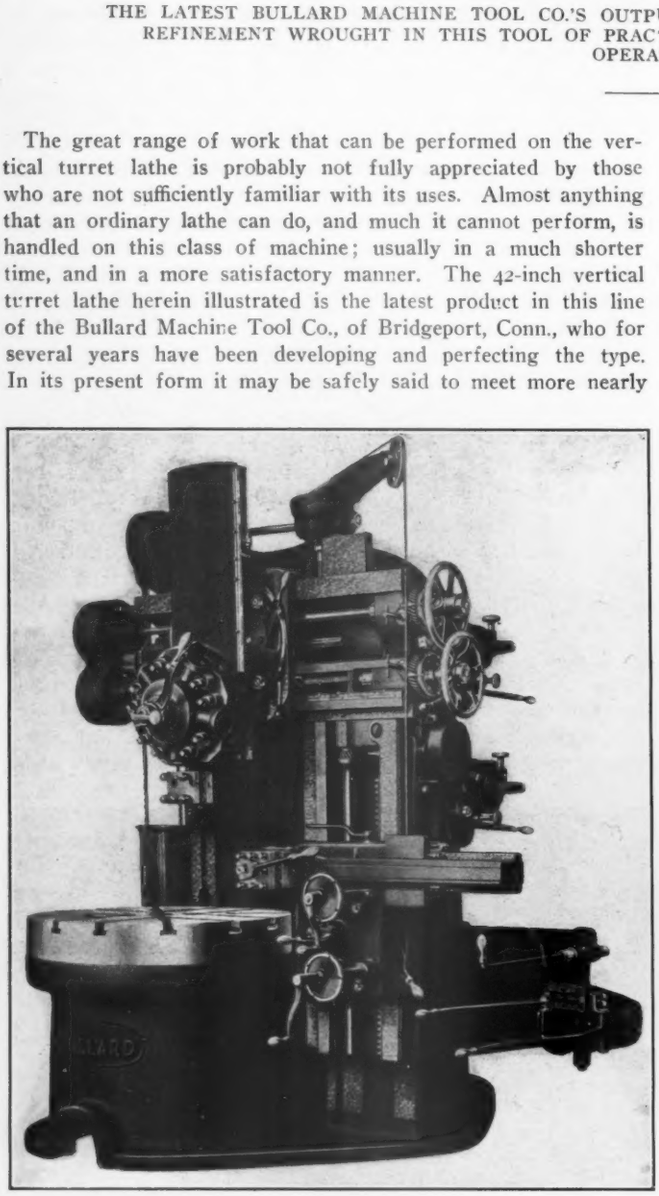
Copies of test matter and other information may be had from the Union Equipment Company, 2312 Oliver Building, Pittsburgh, Pa.

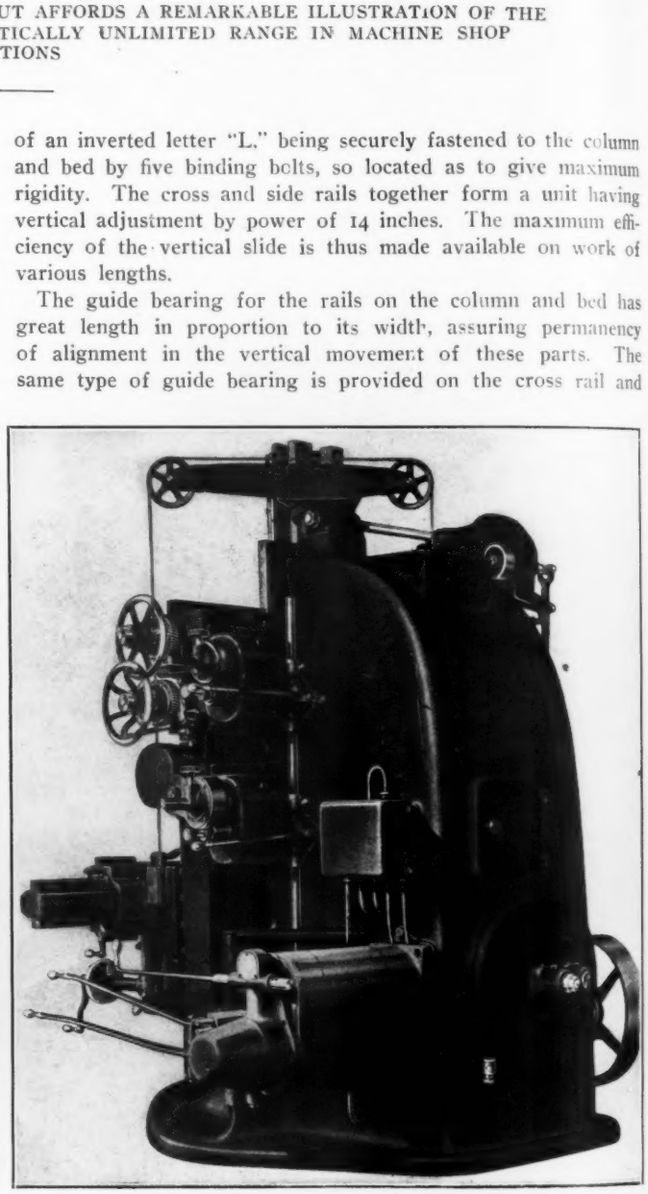
THREE YEARS TO COMPLETE GRAND TRUNK PACIFIC EXTENSION.—According to a railroad official who is in close touch with the construction activities of the Grand Trunk Railway on its Rocky Mountain section and the extension line to Prince Rupert, the western terminus of the road, it will be quite three years before the line is completed to the coast. Unusual engineering difficulties in the mountain section, and the present scarcity of labor, for which there is no relief in prospect, combine to delay completion.

Highly Developed Vertical Turret Lathe

THE LATEST BULLARD MACHINE TOOL CO.'S OUTPUT AFFORDS A REMARKABLE ILLUSTRATION OF THE REFINEMENT WROUGHT IN THIS TOOL OF PRACTICALLY UNLIMITED RANGE IN MACHINE SHOP OPERATIONS

The great range of work that can be performed on the vertical turret lathe is probably not fully appreciated by those who are not sufficiently familiar with its uses. Almost anything that an ordinary lathe can do, and much it cannot perform, is handled on this class of machine; usually in a much shorter time, and in a more satisfactory manner. The 42-inch vertical turret lathe herein illustrated is the latest product in this line of the Bullard Machine Tool Co., of Bridgeport, Conn., who for several years have been developing and perfecting the type. In its present form it may be safely said to meet more nearly





NEW DESIGN BULLARD 42-INCH VERTICAL TURRET LATHE—MAXI-MILL TYPE.

than any other machine tool the exacting requirements of extreme power, continued accuracy, absolute safety of operator, great rigidity, convenience of operation, freedom from breakage, and minimum cost of maintenance, which are the demands of to-day and of the future.

A study of this fine tool impressively emphasizes the high development attained in its design. The many original features embodied are the result of the builders' long experience from the original production of the vertical turret lathe several years ago to the present day, and in the improvements which have been made the fact is quite prominent that items which would ordinarily be associated with secondary importance have been accorded equal consideration with those of more vital moment.

The basic strength of the machine, which is so distinctive a characteristic of the Bullard output, is primarily in evidence. The base and column are cast as a unit; of box construction; internally braced, providing an exceptionally rigid member. It will be noted that the cross rail is of unusual dimensions, and that its bearing on the face of the column is the latter's full width. It is secured to the column by four binding bolts at the extreme points of the bearing. The side rail has the form of an inverted letter "L," being securely fastened to the column and bed by five binding bolts, so located as to give maximum rigidity. The cross and side rails together form a unit having vertical adjustment by power of 14 inches. The maximum efficiency of the vertical slide is thus made available on work of various lengths.

The guide bearing for the rails on the column and bed has great length in proportion to its width, assuring permanency of alignment in the vertical movement of these parts. The same type of guide bearing is provided on the cross rail and side rail for the saddles. The tilting and binding of heads on the rail, due to cutting strain, is thereby prevented; the efficiency of the feed works largely increased, and accuracy fully maintained. The rail and saddle, saddle and slide are solid square locked throughout, no bolted on gibs of inherent weakness being used, and all adjustments for wear are made by taper gibs. The entire general arrangement is representative of rigidity to an unusual degree, although in a casual examination this is somewhat obscured by the extremely graceful contour of the machine as a whole.

There is one vertical head, which will face 44 inches, with a vertical movement of 27 inches, and one side head, each head being independent in its action, both as to direction and amount of feed. The two heads can be operated jointly on work of small diameter without interference. An absolutely accurate center stop is provided for the main head, which is so designed as to permit the head to be carried beyond the center 3 inches. This stop mechanism is unique in design and does not present the inherent weakness and consequent inaccuracy of the ordinary center stop. The swivel base of the main head has a diameter equal to the full width of the saddle, being secured

thereto by numerous binding bolts, thus adding an element of unusual strength to these parts. Angular adjustment up to 45 degrees on either side of the vertical center is obtained by a system of gearing.

The turret is 16 in. diameter, with five faces, the steel bushed holes therein being 2¾ in. diameter. Being set at an angle the turret will swing large tools clear of the slide. It is revolved by the lever plainly shown in one of the illustrations, one turn being equal to each face of the turret. The turret slide has an exceptionally broad bearing on the swivel base, and is also provided with the type of guide bearing previously referred to. Special provision is made for maintaining alignment with the center of the table. Half-boxes, secured to the turret by two binder bolts, bear on the split steel bushings in the turret holes, securely holding the shanks of tool holders, boring bars, etc. As no frictional binder is sufficient, however, to resist the twisting strain set up by a heavy cut, a pin of large diameter, located at the inner end of the turret holes, enters a slot in the end of the bar or tool holder and acts as a driver. The tool holder may be partially withdrawn and disengaged from the driving pin to properly set a tool for cutting at or near the center, which is not possible with a key or key way.

The side head, which does not swivel, has a vertical movement of 28 in. and a horizontal movement of 21 in. The maximum distance from the table to the underside of the cross slide is 25 in. Quick hand movement in all directions is provided, also means for making fine adjustment, independent of the feed works. A four-faced turret holder on the side head obviates the necessity of a constant change of tools, and 1½ in. by 1¼ in. tool steel may be used.

The table is driven through accurately planed bevel gearing, having a special tooth form, which has a rotative effect only. Experiments extending over a period of many years have proved the bevel drive to be superior to the spur drive—notably in the smoothness of the cut and the absence of chatter and tool marks. The table spindle is of the standard Bullard type, as shown in the sectional drawing, having an angular thrust bearing of large diameter, the side strains being absorbed by vertical cylindrical bearings of exceptionally ample proportions. All bearings are accurately and concentrically ground on a special machine, designed and built for this specific purpose.

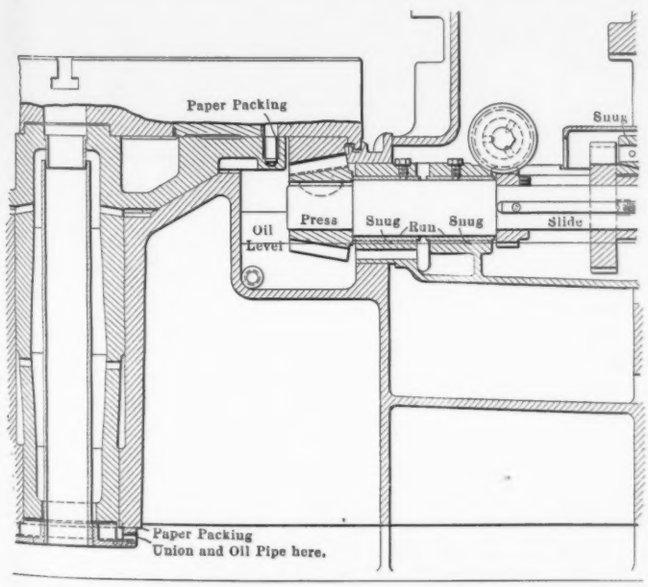
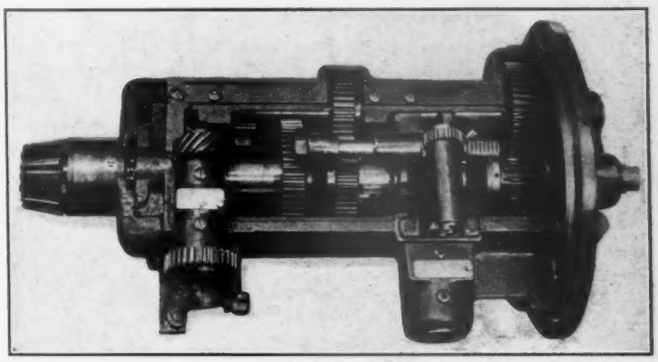


TABLE SPINDLE AND LUBRICATION.

The spindle journals are of cast iron, scraped to create a bearing on the spindle. No adjustment is required and, therefore, is not provided. The entire spindle is immersed in oil, which is supplied in the manner to be described.

With the main driving pulley running 360 r. p. m., the following 12 speeds are mechanically obtained: 3.1, 4, 5.5, 7.1, 9, 11, 16, 20, 27, 34, 46 and 60 r. p. m. The speed changes are effected through two systems of selective sliding gears, one of which is illustrated, and positive clutches. Only gears transmitting power are in mesh—no power being consumed by idle running gears. It may be of interest in this connection to mention that alloy steel gears, specially heat treated, are used throughout the entire driving and feed train of this machine, with the single exception of the table gear, which is of such proportions that it cannot be successfully heat treated. A special alloy, however, having exceptional wearing qualities in an unhardened state, is used in this gear.

A multiple speed clutch disc, readily adjustable, is interposed between the main driving shaft and the primary speed change device, and the members running at constant speed its efficiency



SELECTIVE SLIDING SPEED GEARS.

does not vary. The brake parts are integral with the driven member of the disc clutch, and, while running at constant speed, have a constant braking value, regardless of table speed. The clutch and brakes are operated by one lever, the engaging of one disengaging the other. Anyone of the four primary speeds may be selectively engaged by means of a second lever, and the secondary speed changes are obtained in like manner.

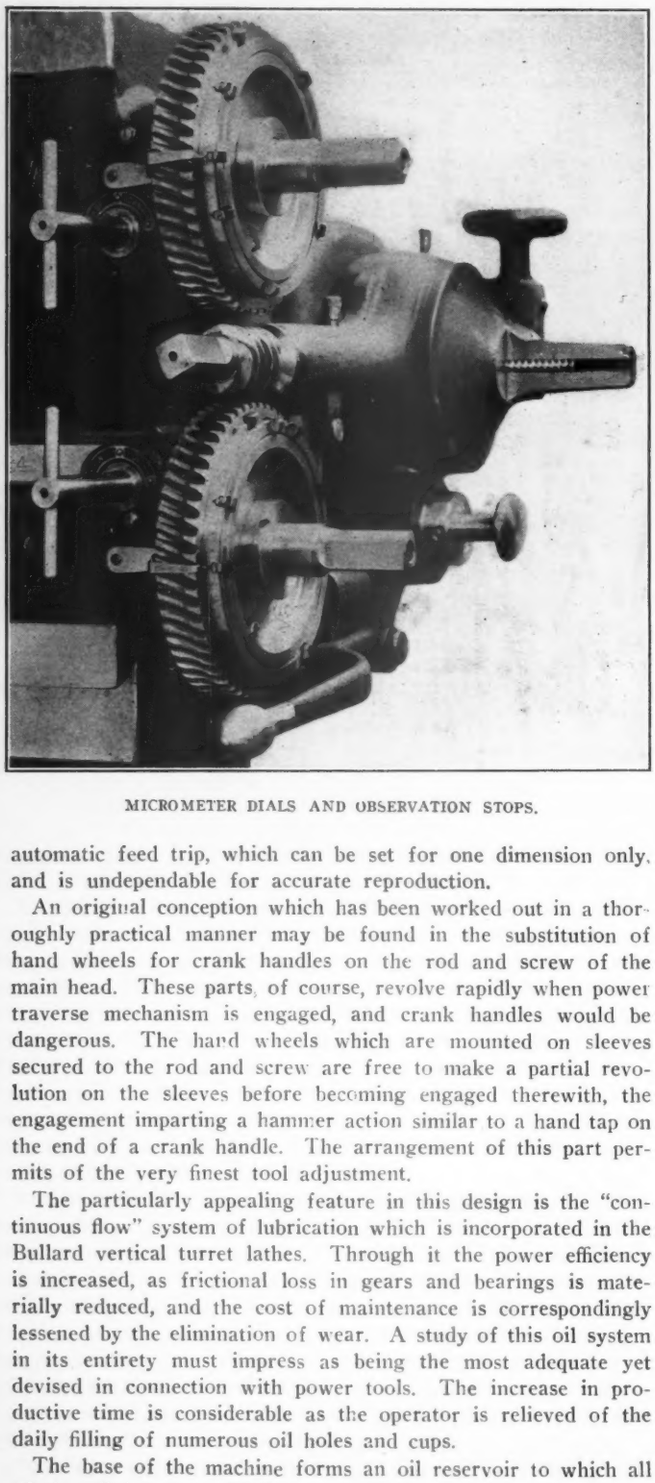
The controlling levers are positively interlocking. The clutch must be released and the brake engaged before a speed change can be made. A complete engagement of gears for any speed is necessary before the brake can be released and the clutch re-engaged. This system of interlocking does not in any way interfere with rapid manipulation, and it serves as an absolute safeguard against breakage due to careless handling. The location of all operating levers and handles in a position convenient to the operator, as is clearly shown in the illustrations, affords an important factor conductive to greater output. Centralized control permits the operator to concentrate on productive effort, which is not interfered with by unnecessary steps from one part of the machine to another. The number of table revolutions per minute may be instantly ascertained from a direct reading indicator incorporated in the interlocking device.

Among the many meritorious features of improvement which may be found in this machine, the refinement to which the feed works and details have been brought is worthy of special consideration. The feed works for each head are entirely independent, and so located as to be conveniently operated. Feeds for both heads are positive and independent, and have 8 changes, ranging from 1/96 in. to ½ in. in all directions. The feed changes are instantly obtained by turning a knurled wheel, and the amount of feed per revolution is indicated on a direct reading index plate on each feed box. The feed is engaged or disengaged, or change made from vertical to cross feed, or vice versa, by engaging the centrally located drop worm gears on the end of feed rod and feed screw. Safety devices which are incorporated in each feed works insure against breakage of gears or mechanism by careless handling of the heads.

The machine is most thoroughly provided with information readings for the operator. An accurately graduated scale is attached to the main turret slide, and a similar scale is made part of the cross rail face. A scale is also attached to the tool slide of the side head; these scales proving of material assistance in the setting of tools. Index dials accurately gradu-

ated in thousandths of an inch are mounted on the feed rods of both main and side heads. These dials, being of large diameter, have the graduations widely spaced and hence are exceptionally distinct and readable.

Observation stops, bearing numbers to correspond with those on the faces of the turrets, are adjustably mounted on graduated scales and micrometer dials, and are invaluable in the duplication of various sizes. They do not present the limitations and objectionable features, mechanical and otherwise, of the



MICROMETER DIALS AND OBSERVATION STOPS.

automatic feed trip, which can be set for one dimension only, and is undependable for accurate reproduction.

An original conception which has been worked out in a thoroughly practical manner may be found in the substitution of hand wheels for crank handles on the rod and screw of the main head. These parts, of course, revolve rapidly when power traverse mechanism is engaged, and crank handles would be dangerous. The hand wheels which are mounted on sleeves secured to the rod and screw are free to make a partial revolution on the sleeves before becoming engaged therewith, the engagement imparting a hammer action similar to a hand tap on the end of a crank handle. The arrangement of this part permits of the very finest tool adjustment.

The particularly appealing feature in this design is the "continuous flow" system of lubrication which is incorporated in the Bullard vertical turret lathes. Through it the power efficiency is increased, as frictional loss in gears and bearings is materially reduced, and the cost of maintenance is correspondingly lessened by the elimination of wear. A study of this oil system in its entirety must impress as being the most adequate yet devised in connection with power tools. The increase in productive time is considerable as the operator is relieved of the daily filling of numerous oil holes and cups.

The base of the machine forms an oil reservoir to which all of the oil is returned after passing through the various bearings and gear boxes. Submerged therein, and direct-connected to the main driving shaft, is a gear pump of more than ample capacity, which delivers the oil to a distributing reservoir located on the outsde of the column, at such height as to insure sufficient head for the free flow of oil through the ducts leading therefrom to the bearings and individual reservoirs, in which the gears revolve; the excess oil pumped to the distributor being returned to the sump by an overflow pipe. The oil sights in the ducts are unique in that the free flow of oil is clearly indicated in two ways—by the size of the oil column passing the opening if the pipe is clear, and by the overflowing at the opening if the pipe becomes stopped up.

The sectional drawing clearly indicates the construction of the table spindle and the method of lubricating this member. The lubrication of the table driving gear and pinion is also shown. All gearing is constantly immersed in oil.

The maximum pressure permitted on the table is 75 pounds per square inch, which would imply a solid body of iron the full table diameter and maximum height of turret. Under the severest conditions no more pressure can be imposed than 62.9 pounds per square inch, only about one-third that borne by a single locomotive driving journal. The flow of oil to bearings is .02 quart per square inch per minute, or one quart to 50 sq. in. projected bearing area.

A 10 h.p. constant speed motor, having a speed not to exceed 1,200 r p. m., may be mounted on a bracket at the rear of the machine and connected with the driving pulley by belt. The machine being self-contained, no expensive foundation is required. The net weight on the floor is 18,500 lbs.

FROM QUEBEC TO FLORIDA WITHOUT CHANGE OF CARS.—Excavation for the foundation of the $20,000,000 bridge and viaduct of the New York Connecting Railroad has started, and the work of building the three miles of bridge work and the three miles of railroad on land that are to connect the Port Morris yards of the New York, New Haven and Hartford Railroad with the Long Island and Pennsylvania systems in the Sunnyside yards will begin as soon as the foundations are completed. As passenger trains will go direct to the entrance of the Pennsylvania tunnel in the Sunnyside yards, it will be possible to transport passengers without change of cars from Quebec to Florida.

LOCATION OF THE NEW HAVEN'S NEW $2,000,000 STATION.—Following the placing of the location of a new station at New Haven in the hands of President Mellen, by the directors of the New York, New Haven and Hartford Railroad, Mr. Mellen has issued an official statement to the effect that the station will be erected upon the water front near the present depot. The structure will cost between two and two and a half million dollars.

B. AND M. TO HAVE NEW REPAIR SHOP.—Decision has recently been reached to locate a new and extensive repair shop of the Boston and Maine system at North Billeric, Mass. The plant will approximate $3,000,000 in cost and will employ between 1,200 and 1,500 men. Proposals were received by the company urging the location of the shop in not less than twenty-two cities and towns.

THE ANNUAL CONVENTION of the Railway Tool Foremen's Association is to be held at the Wellington Hotel, Jackson Boulevard and Wabash Avenue, Chicago, Ill., July 11th to 13th inclusive. This Association was formed by Railway Tool Foremen to hold a meeting each year for discussing subjects pertaining to railway tool work, thus attaining Higher Efficiency in the Railway Tool Service.

IT IS STRANGE BUT TRUE that it should be so difficult to persuade the owners of a property to accept greater profits with small investments. It is equally true that the Scientific Manager will find it more difficult to educate his superiors than his inferiors.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

THE UTAH LEGISLATURE has before it a bill making it compulsory for railroads to grant free transportation to state officers, judges of the supreme and district courts, members of the Legislature and county sheriffs.

MALLET LOCOMOTIVES WITH HOBART-ALFREE VALVES AND CYLINDERS

MEXICAN INTERNATIONAL RAILROAD.

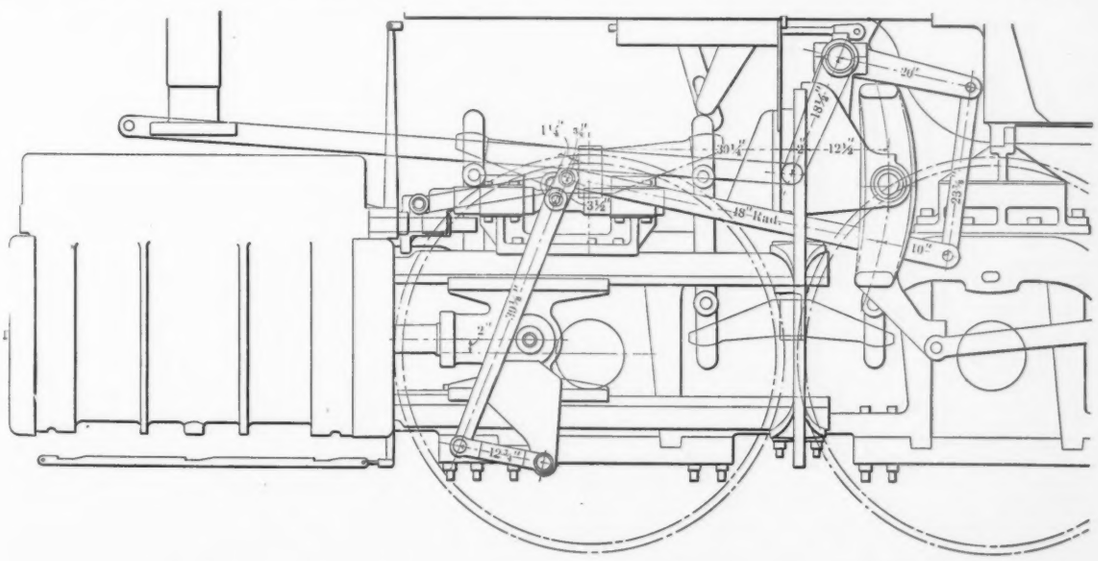
Early in 1907 the National Railway of Mexico purchased 6 Pacific type passenger locomotives, which included an example of four different cylinder arrangements and of three different valve gears. One locomotive was of the Cole balanced compound type with Walschaert valve gear; one was a simple locomotive with the Alfree-Hubbel valves and cylinders using a Stephenson valve gear; three were simple locomotives with Stephenson valve gear, and one was a Baldwin balanced compound with Stephenson valve gear. These locomotives were put into service on the same division and after being operated for some time they were given a complete comparative test to determine the relative efficiency. Upon the completion of these test runs the locomotives were again put into the regular service and operated for one year, careful records being maintained to discover if the operating results would check the test figures. The net result of this work was the determination of the company to apply Alfree cylinders and valves to a number of consolidation locomotives, five being first equipped. After these had been in service for some time it was decided to equip more of the same type and at present a group of sixty consolidation locomotives are being fitted with cylinders and valves from the Hobart-Alfree Company as fast as the engines go through the shop. Furthermore, when it was decided recently to purchase 20 locomotives of the Mallet type, valves and cylinders of this design were again specified.

MALLET LOCOMOTIVE WITH HOBART-ALFREE VALVES AND CYLINDERS.

These locomotives have recently been delivered by the Baldwin Locomotive Works and are designated as Class H in the railroad company's classification. They are designed for service on a line having curves of 21 degs. and grades of three per cent. and are similar in many respects to the 2-6-6-2 type locomotive built for the Mexican Central Railway in 1908 (see AMERICAN ENGINEER, December, 1908, page 477). They are equipped with neither a superheater or reheater and a simple straightforward design of steam piping has been applied.

The Alfree design of valves and cylinders was fully illustrated and described on page 334 of the September, 1906, issue of this journal and on page 408 of the October, 1910, issue, where they were shown in connection with a new type of radial valve gear. As was explained in the later article, this design of valves and cylinders can also be used with the regular Walschaert valve gear and in the case of these Mallet engines they have been so arranged.

Briefly, this type of valve consists of a large main valve constructed in front and back sections cast in one piece with a longitudinal body, the latter being elliptical in cross section. This arrangement permits very short and direct steam ports and acts the same as an ordinary slide valve, being set with the same lead and given the same lap as would be used with the customary construction. In addition to this main valve, which is set at an angle so as to permit room, there is an auxiliary compression valve, which is of the piston or plug type and is operated from a separate connection on the combination lever. This compression valve simply opens and closes a passage in the wall between the cylinder steam ports and the exhaust passage. It remains open after the exhaust closure of the main valve and permits the steam to escape from the cylinders to practically the end of the stroke. The cylinders are so constructed as to give the minimum amount of clearance, permitting the exhaust closure to be carried up to a very late point in the stroke and still give sufficient compression to avoid shock. The compression valves have no other duty than to simply open this passage to the exhaust at the same time that the main valve opens its exhaust and to remain open as just explained. The compression valve

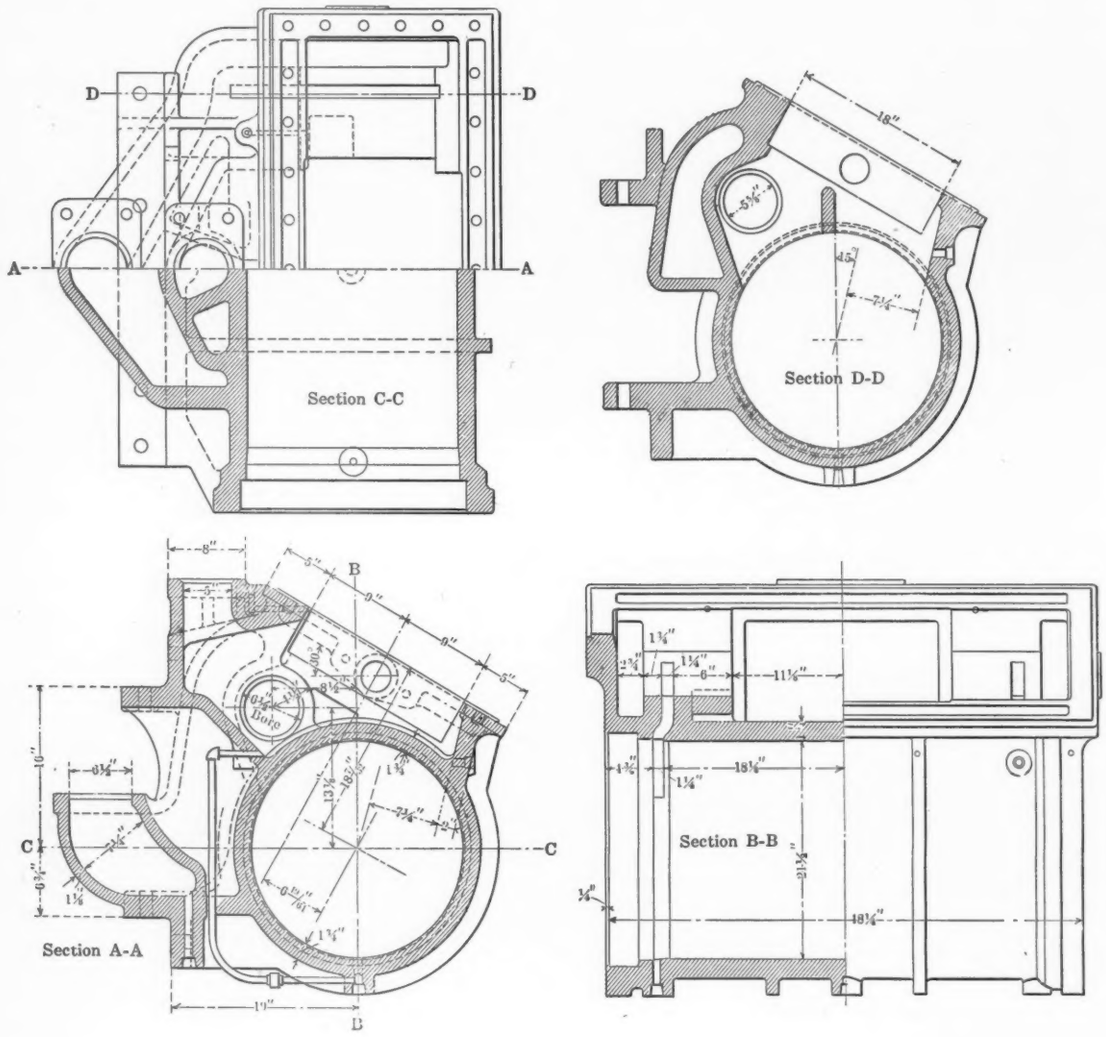


ARRANGEMENT OF VALVE GEAR ON MEXICAN INTERNATIONAL RAILWAY 2-6-6-2 TYPE LOCOMOTIVE.

in this case is 5½ in. diameter and is packed with broad cast iron rings which have leakage grooves turned in them. Reference to the illustration will show the arrangement of the gear as fitted to operate both valves properly and of the high pressure cylinder castings.

VALVES.

Kind	Hobart-Alfree
Greatest travel	6 in.
Outside lap	1⅛ in.
Inside clearance, H. P.	7/16 in.
Inside clearance, L. P.	⅜ in.
Exhaust clearance, compression valve	⅛ in.
Lead	3/16 in.



DETAILS OF CYLINDERS, MEXICAN INTERNATIONAL LOCOMOTIVE.

The general dimensions, valve setting, etc., of these locomotives are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Oil
Tractive effort	69,500 lbs.
Weight in working order	338,500 lbs.
Weight on drivers	298,200 lbs.
Weight on leading truck	20,000 lbs.
Weight on trailing truck	20,300 lbs.
Weight of engine and tender in working order	510,000 lbs.
Wheel base, rigid	10 ft.
Wheel base, driving	30 ft. 1 in.
Wheel base, total	46 ft.
Wheel base, engine and tender	79 ft. 2½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.32
Total weight ÷ tractive effort	4.86
Tractive effort × diam. drivers ÷ heating surface	827.09
Total heating surface ÷ grate area	70.20
Firebox heating surface ÷ total heating surface per cent	4.40
Weight on drivers ÷ total heating surface	63.70
Total weight ÷ total heating surface	71.80
Volume equivalent simple cylinders, cu. ft.	20.75
Total heating surface ÷ vol. equiv. cylinders	227.00
Grate area ÷ vol. equiv. cylinders	3.23

CYLINDERS.

Kind	Compound
Diameter	21½ & 33 in.
Stroke	32 in.

WHEELS.

Driving, diameter over tires	56 in.
Driving, thickness of tires	4 in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	28½ in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	28½ in.
Trailing truck, journals	6 x 12 in

BOILER.

Style	Straight
Working pressure	220 lbs.
Outside diameter of first ring	80 in.
Firebox, length and width	124 1/16 x 78 in.
Firebox plates, thickness	⅜ & 9/16 in.
Firebox, water space	6 in.
Tubes, material and thickness	Steel, No. 12 B. W. G.
Tubes, number and outside diameter	365-2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	4494 sq. ft.
Heating surface, firebox	207 sq. ft.
Heating surface, total	4701 sq. ft.
Grate area	67 sq. ft.

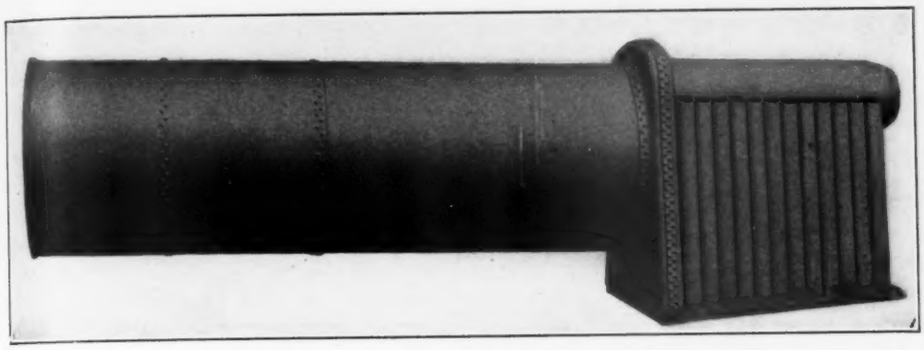
TENDER.

Tank	Vanderbilt
Frame	6 x 4 in. angles
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Fuel capacity	4,000 gals.

THE McCLELLON LOCOMOTIVE BOILER

There are three features which take precedent in connection with an ideal boiler for locomotives, viz., the greatest evaporation per square foot of heating surface; highest degree of safety and lowest cost of maintenance. In importance these take about the order named.

In stationary practice the water tube boiler has very largely displaced the fire tube because of the much greater capacity per unit of weight and floor area with this type, but in locomotive practice the so-called water tube boiler, which usually means water tube fire box, has not met with any great favor, in spite of the fact that thoroughly reliable tests have shown it to have an increased capacity in the same sized boiler of nearly 20 per cent. This lack of enthusiasm over the water tube fire box is probably very largely due to the feeling that the third factor mentioned above has suffered to an equal or greater extent than the first factor has gained and the advantages cost more than they are worth. So far as is known, this fact has not been proven, and it is doubtful if, where properly designed construction is used, it would prove to actually be the case in regular service. Nevertheless, the three factors mentioned must all be kept prominently in mind and none of them allowed to suffer at the expense of the others in the case of an ideal boiler.



GENERAL VIEW OF THE MCCLELLON BOILER.

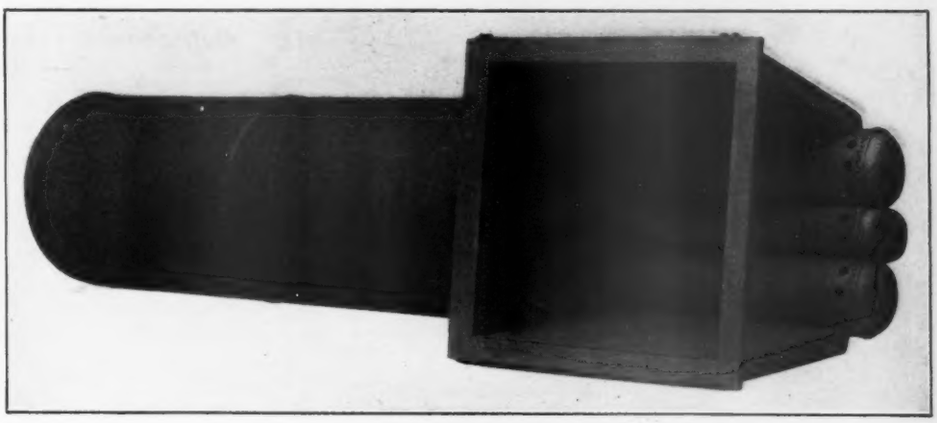
It is with this understanding that James M. McClellon, of Boston, has designed the boiler shown in the accompanying illustrations, which, while it incorporates many of the principles and advantages of the water tube type, differs decidedly from previous designs along those lines and can hardly be classed as a water tube boiler. This design has not been discovered by Mr. McClellon, but is the result of many years' experiment and investigation.

In general, this fire box consists of a series of large tubes flattened on two sides and curved to different radii on the other sides, which are placed adjoining each other with the flat sides in contact for the length of the side wall of the fire box. The back head is made up of similar tubes shaped to take care of the difference in width at the top and bottom and arranged to leave an opening for the fire door. At the bottom there is a large ferrule expanded into openings through two adjacent tubes, giving access for the supply of water. The two adjacent tubes are riveted together by four rivets at the point where the ferrule is inserted. At the tops, the ends of the tubes are formed to fit the side of the drums shown in the illustration, and here again a ferrule is expanded in an opening in the tube and drum and four more rivets are used to secure the construction. The top of the tube is closed by a flanged section or head, with the flanges extending upward, the rivets being on the outside, while the bottom is also provided with a similar head. The form of construction at the bottom consists of extending the sides of the tubes down and bolting them to the regular mud ring, this joint not being steam tight, as the flanged heads riveted in the end of the tube hold the pressure.

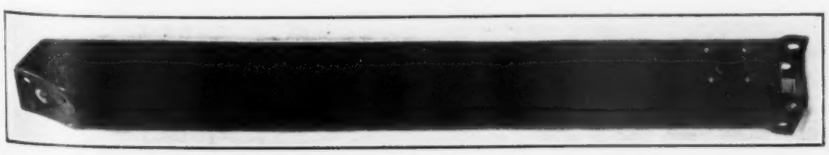
The upper section of the fire box consists of three large drums, the center one being egg-shaped and the outer two being flattened to form a connection with the center, which are riveted to openings flanged in the back flue sheet and are closed with bumped heads with or without manhole openings at the rear. These three drums, which are large enough to permit a man to work inside, have interconnecting openings fitted with expanded ferrules at frequent intervals. A row of stay rods is inserted across the center drum and adjacent drums are riveted together at the ferrules.

The back flue sheet and the throat sheet take the form of the Bellpaire boiler and are secured together, giving a wide water leg in the manner clearly shown in the illustration. Staybolts, of course, are required for these flat sheets, but at no other point in the boiler are staybolts used.

The opening for the fire door in the back head is arranged by simply cutting away four of the tubes to give the proper space and closing the ends up with flanged heads, the same as are used at the top of the side elements. The bottom sections are provided with extra circulating openings and similar openings are arranged above the fire door. In the case of the back head the elements adjoin the upper drums at the bottom of the shell and are simply shaped for the proper fit and flanged cups or heads inserted and expanded ferrules used the same as on the side elements. Washout plugs, not shown in the illustration, are provided near the top of each element and over the fire doors, or other places wherever necessary.



VIEW SHOWING TOP DRUMS OF MCCLEELON BOILER.



TUBE USED TO MAKE UP THE SIDE WATER LEG.

The shape of the tubes making up the side wall is interesting, the curves on the outer and inner faces have been carefully designed to suit the different conditions of temperature, the inner ones being subject to a greater expansion are curved at a shorter radius and are so arranged as to give a flexibility within themselves, which s capable of taking up all local expansion and not setting up any strains in the connections or having any effect upon the

flue sheet. The outer face is curved at a larger radius, giving an increased stiffness and strength. These tubes are formed from commercial seamless tubing, in which a particularly high quality material, permitting very thin metal being used, can be obtained.

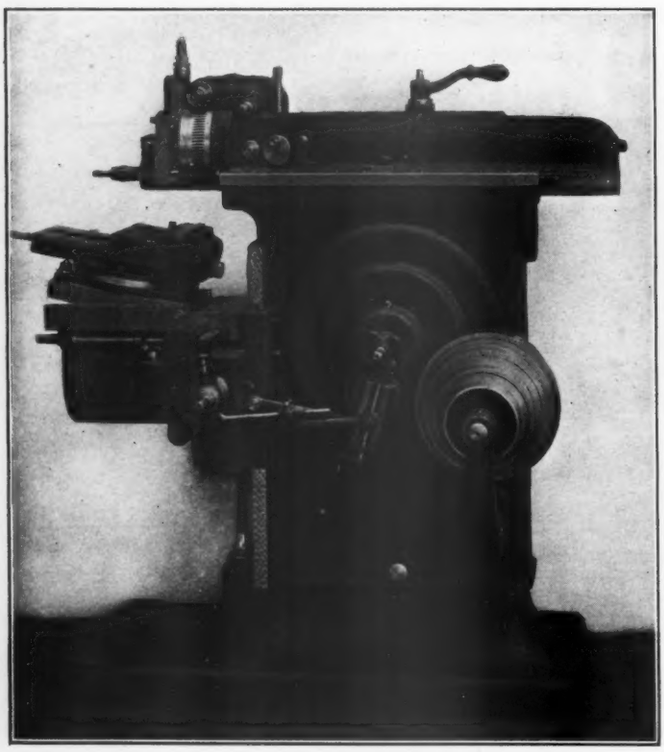
The advantages which this form of fire box seem to offer are, the more rapid, positive and efficient circulation found in water tube boilers; the shape of the side sections taking up the expansion strains and largely reducing flue and mud ring leakage; the entire elimination of staybolts, with its many advantages; the taking of all rivets or caulked joints and seams away from the fire, and the possibility of renewing damaged sections without renewing the whole side sheet and the increased safety from explosion dependent upon these features.

It is expected that a model of this boiler will be on exhibition in space 526 at the coming convention.

AN INTERESTING UNIVERSAL SHAPER

The 16-in. single geared shaper herewith illustrated has been designed by the Stockbridge Machine Company to meet conditions where a universal shaping machine that can be worked to or within limits is necessary, and it is fitted with many special attachments fitting it for practically every possible requirement of a shaper for tool room or die work.

Prominent among the special features is the power rotary



feed to the tool slide, which is mounted on top of the ram. The head is revolved by a worm and worm gear, the worm being connected to the pawl shown on the side of the ram by a train of gears. The reciprocating motion of the pawl is imparted by a dog, which is adjustable along the ram gib, and can be set to give any desired amount of throw to the pawl; the amount of throw determining the amount of feed to the worm gear. The worm can be rotated in either direction and the construction is such that when desired the head can be rotated by hand. When the rotary head is not in use it is locked to the ram by means of two bolts on either side of the head.

The head slide is provided with an automatic stop for the down feed which will be found of advantage in the duplication of parts. The stop prevents the tool from feeding down too far and spoiling the work, and it also allows the operator to attend to other work while the machine is running. An automatic feed, either up or down, is also provided for the head slide. The micrometer or down feed screw is graduated to read to .001 of an inch, and can always be set at 0. The amount of feed is regulated by the position of the dog on the ram gib. If desired, the feed to the slide can be operated by hand. The swiveling, or rotary, knee, with two working sides is revolved by the worm and worm gear through an arc of 90 degrees in either direction. One side is made to tilt for planing angles, and is especially useful in die making.

This shaper has the Stockbridge patented two-piece crank, giving a quick return of 3.5 to 1, and an even cutting speed the entire length of the cut. This quick return is maintained on short strokes, which is not possible with any other crank motion. The finished weight of the machine is 2,000 lbs. The actual length of the stroke is 16½ in.; vertical travel of the knee, 16 in.; horizontal travel of the knee, 20½ in.; ram bearing in the column, 26 in., and for key seating it takes a 3-in. shaft.

PREVENTING SCALE IN BOILERS BY AID OF ALUMINUM PLATES

A paper upon the above subject, which created considerable interest, was read at the last meeting of the New York Section of the Society of Chemical Industry by Thomas R. Duggan, of 20 Beaver street, New York.

After reviewing the necessity of a pure water for boilers and technical purposes the author went on to describe the method by which some most interesting results have been obtained in practice, and stated:

"After a long period of experimenting and after many trials, an inventor, a German scientist, Herr Brandes, discovered an apparatus—'The Luminator'—which gave to ordinary water, after simply flowing over it, certain remarkable properties. For instance, when used in steam boilers, much less scale was deposited, old scale was softened and detached from the plates, especially the flues, steam was dryer, and less coal was required in steam raising, and generally the salts were found as a powder in the bottom of the boiler, whereas otherwise they would have formed hard scale.

"The treatment consists simply of allowing water to run down an aluminum plate of special dimensions, with corrugations of a particular size, according to the character of the water to be treated.

"No chemicals are required; it is only necessary to brush well the corrugations to keep them clean and free from deposit. No scale chipping hammers are required where this apparatus is used, nor drilling machines required to drill out tubes of watertube boilers or economizers. In most cases where this method has been used the smooth and enamel-like appearance of the flue plates and surfaces has been remarked after brushing away the powder formed.

"When storage tanks and mains are far from the boiler it is necessary that they be coated with a non-conducting composition —any bituminous varnish will do—and that water reach the boiler as soon after treatment as possible. To get the maximum effect the water must be used within seven days after its treatment; hence storage tanks should not be too large. Where water is used continuously night and day, it may be found necessary to give the apparatus about one day per week rest, as the plates under certain conditions become polarized. This only happens under very unfavorable conditions, and in most cases may be neglected altogether.

"The action of the 'Luminator' is that, by the passage of water over the metal channels at certain speeds, a current of electricity is induced, the water being negative and plates positive, ionization of the salts takes place, and they do not take a crystalline form, but become amorphous; at the same time a

new and particular action goes on; that is, aluminum is by friction and electrical action abraded from the surface as a colloid, which after a period undergoes change in the water. This action was investigated by Professor Donnan at the Liverpool University, who found that aluminum hydroxide was not present in water treated by the apparatus to any extent, but on turning to the ultra-microscope he was enabled to see that the aluminum was in the colloidal form mixed with hydroxide and remained so for several days.

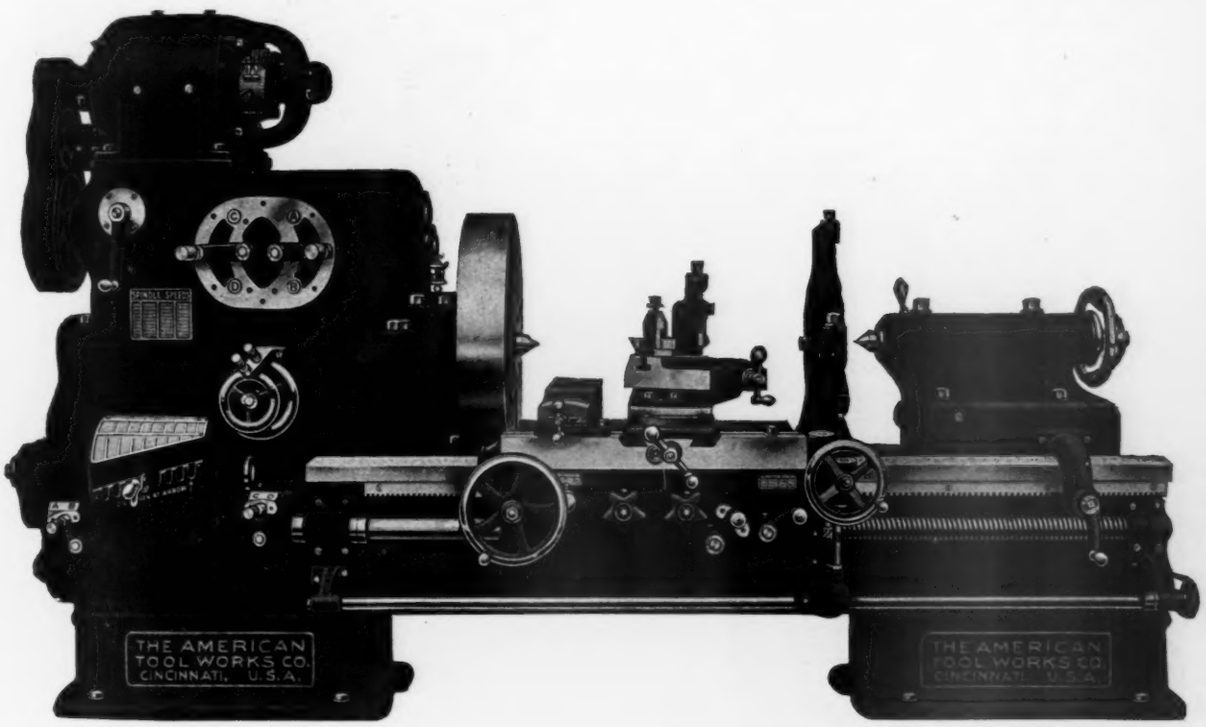
"It has been found that the best results are obtained when the 'Luminator' is facing either north or south and exposed to direct light, and that if closed in entirely from light and air the apparatus becomes almost inoperative. From observations made by the inventor, who had met with some failures of the apparatus when placed facing certain directions, he assumed that the earth's magnetism had some effect; therefore it occurred to Professor Donnan that if the plane of the aluminum sheet was set so that the earth's magnetic field cut across it, there would be produced, when the water flowed down the apparatus, a small electromotive force at right angles to the longitudinal grooves of the aluminum sheet, with the result that a slight electrolysis would occur, precipitating aluminum hydroxide in the solution."

NEW DESIGN HIGH DUTY LATHE

Nearly everyone knows that the most essential and universally used of machine tools is the lathe, but the changes it has undergone during a very recent period are such as almost to entitle it to a change of name. Like every other machine tool, it has come through a process of evolution, and has increased in power and resource in conformity with the demands which modern need and methods have imposed. The simple principle of the lathe, that of rotating the work to a stationary cutting tool, is so apparent that it may have been, and possibly was, discovered by more than one person in more countries than one, and it has finally become one of the most useful machines the mind has yet devised, and may almost be described as a machine for producing anything.

This thought naturally occurred in the consideration of the fine tool herein illustrated, which represents the latest output of the American Tool Works Company of Cincinnati, O. This is an important advance in design, and it deserves particular mention, as among other striking and prominent points of superior merit it embodies an abundance of metal just where it is needed to insure the utmost rigidity, thereby overcoming all chatter and vibration, which results in true smooth work. Rigidity is a primary object in machine tool frames, limited only by commercial considerations and convenience, but it is often lost sight of or seriously impaired by faulty arrangement and design.

In this case the bed is of deep section, exceptionally heavy, and thoroughly braced by cross box girths at short intervals its entire length, affording a degree of rigidity sufficient to resist the heaviest cuts without vibration. The patented "drop V pattern" gives great additional swing, and permits of adding considerable metal to the depth of the carriage bridge. This in-



MOTOR DRIVE THROUGH "PATENTED" 12-SPEED HEAD.

sures much greater strength to resist the downward thrust of the tool than the equivalent widening of the bridge, which is commonly resorted to in the design of similar machines.

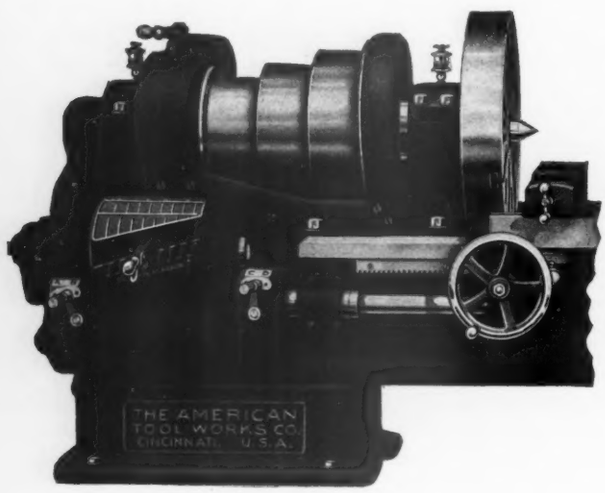
The method of motor application to these 30 and 36 in. American lathes is extremely simple and efficient, only three gears being used in connecting the armature and driving shafts. A constant speed motor, either of the direct or alternating current type, is located on top of the patented geared head, and connected to the main driving shaft through spur gearing. Twelve fundamental spindle speeds are obtainable, 6 to 275 r.p.m., and the motor is under constant control through the controller hand-wheel, which is conveniently located on the right end of the carriage. A feature in this connection quite apparent, and worthy of special mention, is the ease with which a belt driven geared head lathe can be changed to motor drive at any time after installation. A plain surface is supplied on every geared head for this purpose, and it is only necessary to apply the motor, connecting by three spur gears, armature and the drive shafts. It is also prominent that the geared head has been scientifically proportioned to resist all vibration which might originate from the motor, although it is a known fact that

the high grade motor is such a nice mechanism that there is practically no vibration, even when running at the highest speed.

The one feature of these new lathes, which is absolutely new in design, is the quick change gear mechanism that has been developed to a degree exceeding practically all similar mechanisms. In keeping with the original lines which have been followed, representing many features of excellence, may be found all steel gears. Brown and Sharpe 20° involute cutters have been used for cutting these steel tumbler gears, and a tooth is produced pointed at the top, and unusually wide at the base. Experience has proved this style of tooth the only proper one to use in a tumbler gear constrution, as it greatly facilitates the meshing of the gears when running at high speeds, and eliminates all tendency of the gears to ride. The range of changes for feeding and screw cutting provided by this mechanism is practically unlimited. Forty-eight standard changes are shown on the index plate, listing threads from ½ to 28 threads per inch, including 11½ pipe threads, and feeds from 5 to 280 cuts per inch. The rate of feed is ten times the number of threads at the same setting. The index plate is located on the feed box directly over the sliding tumbler, and clearly shows how to obtain each thread and feed. The feed box is a complete unit, embodying what is usually carried in two sections. It consists of a gear box on the front of the bed, with two levers and a steel sliding tumbler, the latter working in conjunction with a cone of eight steel gears.

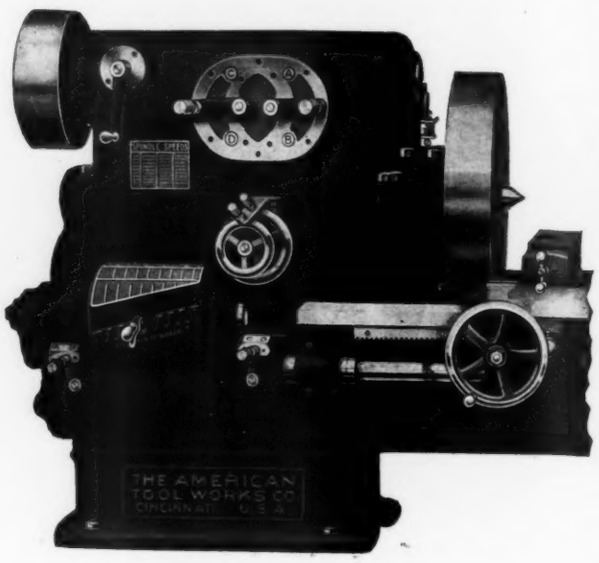
It is frequently necessary to cut odd threads, either coarse or fine, and metric pitches, on the same lathe. By means of the auxiliary quadrant and the use of special gears, any thread or feed can be obtained. Metric pitches are obtained through the English lead screw and transposing gears. This feature is of inestimable value, as it provides for all emergencies of this nature and fits the lathe for a wide range of work, from the finest threads to coarse worms.

The fundamental speed changes are made through the manipulation of the levers and handwheel on the front of the headstock. Motor speed can be comparatively high, 1,000 to 1,200 r.p.m., thereby keeping down the size and first cost of the motor. A sensitive but powerful friction clutch is provided on the driving gear for starting, stopping or slightly moving the gears in the head, to facilitate making speed changes without shock to the parts or interfering with the motor speed. The size of the motor is, of course, dependent upon the nature of the work to be handled. If the lathe must stand up to continuous hard work, a large motor must be used, whereas if it is intended only for a general line of work, one of normal power will be amply sufficient. The power of the motor should be from 7½ to 15 horsepower.



DOUBLE BACK GEARED HEAD.

In addition to these special features the manner in which details have been wrought out in the construction of this machine is of exceptional interest. In particular the design of the tailstock merits a careful examination. This is representative of an extremely massive quadruple clamping stud type, with back bolts running to the top of the barrel for convenience in clamping, and it is further secured against movement by a pawl dropped into a rack cast in the center of the bed, which is exceptionally valuable when doing heavy work. This pawl can be lifted out of engagement by a pull rod on the end of the tailstock. An improved form of plug binder for clamping the spindle has a very long travel, is graduated in inches, and



12-SPEED HEAD, BELT DRIVE.

actuated by a dished handwheel which brings the wheel closer to the operator, and also secures freedom from the lost motion and back lash of the gear operated type. When the spindle is extended, it is given an extra support by a projecting nose on the tailstock, and this is further reinforced by a wide rib, extending from the tip to the base, insuring exceptional rigidity. The rack pinion can be withdrawn so that the tailstock can be removed without running it off the end of the bed.

The carriage is very heavy, especially in the bridge, where it is particularly deep, due to the drop "V" bed, and is widened to the extent dictated by good practice and judgment. The bearings are full continuous, 44 in. on the "V's," and the carriage is gibbed its full length on the back, with a clamp on each end at the front, the right hand clamp being used for binding to the bed. The lead screw is extra large, 2¾ in. diameter, and chased 1 thread per inch, permitting engagement of half nuts at any point without the use of the thread dial, except when fractional threads are desired. It is made from high carbon ground stock, chased from a Brown & Sharp master screw and carefully tested on a special apparatus built for that purpose, thus insuring a lead screw of great accuracy and long life.

Abundance of power is available in these lathes far surpassing the high efficiency of the most improved high speed steels. A minimum of power is wasted throughout the drive of the machine because of the reduction in the number of running parts, together with the most direct form of drive to the main spindle and through the feed works. This, coupled with excellent lubrication, insures the highest percentage of power delivered to the tool. Steel gears are liberally distributed throughout, wherever experience has shown them to be necessary. These are of the coarsest pitch practicable, and are cut from the solid with special cutters, no range cutters being used. All levers, handwheels and controlling mechanisms are placed conveniently for the operator, making the machine a desirable tool to handle. This feature is of particular value on a lathe of this size, where expensive work is being machined and every delay costs money.

OPERATIONS AND TIME REQUIRED FOR MACHINING A 21¼" PISTON ON A 36" VERTICAL TURRET LATHE

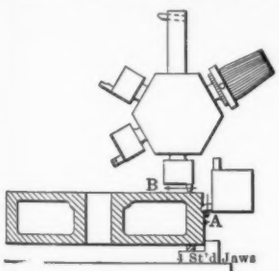
	Item	Surface Machined	OPERATIONS	Depth of Cut	Feed Per Rev.	Rev. Per Min.	Minutes Each Operation	Minutes Required Actual
Setting No. 1	1		Chuck Work				4	4
	2	A	One Tool, 6½" Length of Cut } Simultaneous Cuts.	1/16"	1/3	6	6½	
	3	B	One Tool, 9" Length of Cut }	1/8"	1/3	6	9½	9½"
	4	C	One Tool, 9" Length of Cut } Simultaneous Cuts	1/4"	1/3	6	2½	
	5	D	One Tool, 1"x1" Groove }		1/30	6	11	11
	6	E	One Tool, ¾"x2" Cut	¾"	1/24	6	3	
	7	F	One Tool, 1"x1" Groove		1/30	6	11	11
	8		Remove Piston				2	2
Setting No. 2	9		Chuck Work				4½	4½
	10	G	Set Tool and Finish } Speed up to 34 Rev. after H, I and J are finished. These operations performed while boring "G"	1/16"	1/12	6	20	
	11	H	" " " "	1/16"	1/12	6	1	20
	12	I	" " " "	1/16"	1/12	6	8	
	13	J	" " " "	1/4"	1/3	6 & 20	1¼	
	14	K	Ream				2	2
	15	L	Fillet				½	½
						TOTAL	86¾	64½

Piston in Rough, 21¼"x7", weight, 410 lbs.
Piston When Finished, 21"x6¾" weight, 337 lbs.
Metal Removed, 73 lbs.
Kind of Metal, Hunt-Spiller Metal. Time consumed in Machining Six Pistons, from floor to floor was 8 hours and 10 minutes, including oiling machine, grinding and setting tools and absence from machine that occurs during day's work, average per piston, 81⅔ minutes.

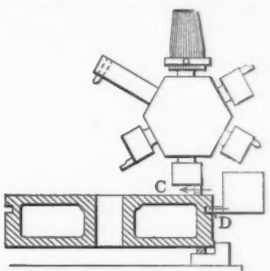
RAPID PISTON HEAD MACHINING

In the January, 1910, issue of this journal an illustrated article describing the operations required for machining a locomotive piston on a 36 in. Bullard vertical turret lathe attracted considerable attention in view of the table in connection therewith which graphically portrayed the quick time made in connection with the various detail operations. By using the vertical turret head and the side head simultaneously the total time in the table referred to was shown to be 90 minutes, a gain of 30 minutes over the two hours actually allowed by the time study.

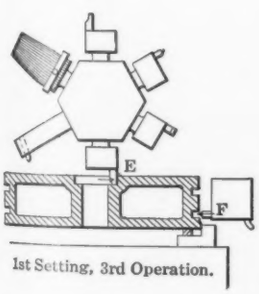
Since this was published it occurred to the master mechanic



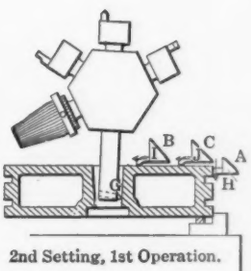
1st Setting, 1st Operation.



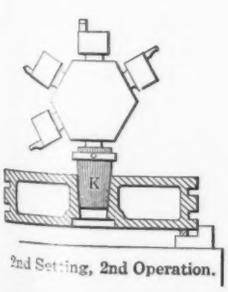
1st Setting, 2nd Operation.



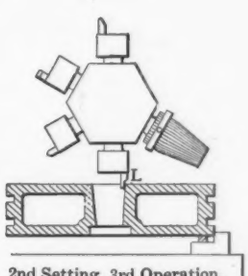
1st Setting, 3rd Operation.



2nd Setting, 1st Operation.



2nd Setting, 2nd Operation.



2nd Setting, 3rd Operation.

of a prominent Southern road that it would be a good idea to determine whether or not he was getting an output from his Bullard machines at least equal to that given in the above quoted record. The result of his efforts is clearly portrayed in the attached working table, which indicates that it is possible to machine the piston head in considerably less time than given.

These figures are very interesting, as they illustrate the wonderful possibilities of the vertical turret lathe when carefully studied and intelligently handled. It will be noted that if each operation had been performed singly it would require 86¾ minutes to complete a piston, but as some of them were done simultaneously, the time was reduced to the remarkable record of 64½ minutes actual time, or, in other words, the head was completed from floor to floor in 64½ minutes. In a striking test made of the average daily output, 6 pistons from floor to floor, were finished in 8 hours and 10 minutes. This included oiling the machine, grinding and setting tools, and absence from the machine which occurs during a day's work. The average time per piston was 81⅔ minutes. This data was taken after the test was made without the workman having any knowledge of it in order that the output under normal conditions might be determined.

RELIABLE ELECTRICAL OPERATION

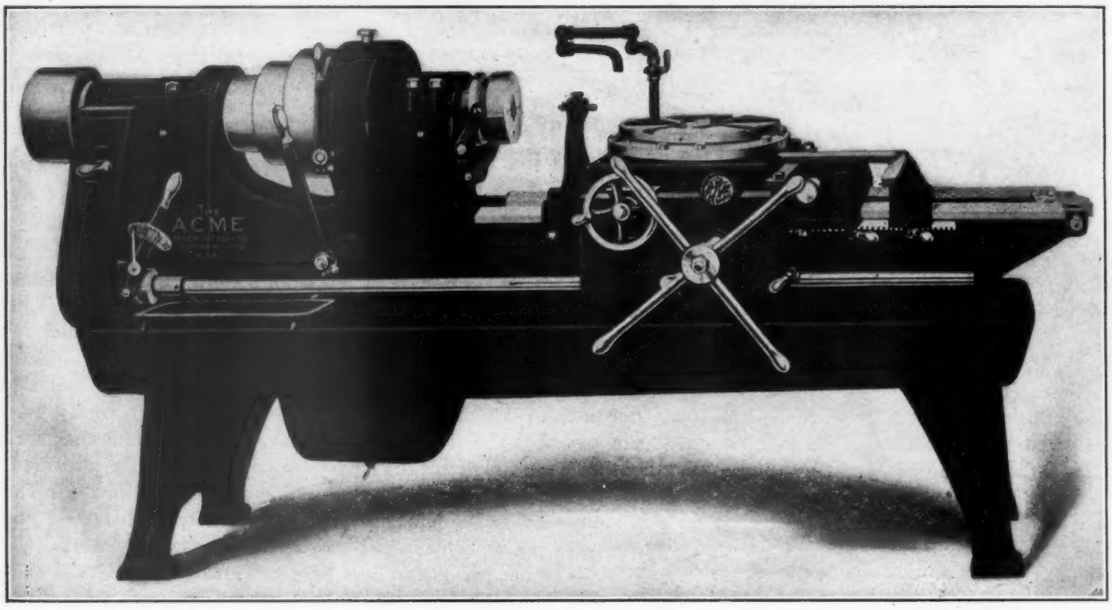
It has been unofficially stated several times recently that the New York, New Haven & Hartford had practically no motive power delays in handling the entire passenger traffic of its New York end by Westinghouse electric locomotives and multiple unit trains, notwithstanding the change over from steam to electricity at Stamford. From reports of train operations in New York State during January, recently given out by the Public Service Commission, it appears that the New York, New Haven & Hartford made the best showing of any road in the state with 90 per cent. of its trains on time.

The report is especially interesting in view of the fact that the New Haven is extending its single phase electrification to the Harlem division and another branch, and reported as planning extension to New Haven. Of the roads entering New York City it is noteworthy that three of the electrically equipped roads, namely, the New Haven, Long Island and Pennsylvania, stand high with 90, 86 and 84 per cent., respectively.

"THE STRENGTH OF OXY-ACETYLENE WELDS IN STEEL," by Herbert L. Whittemore, has just been issued as Bulletin No. 45 of the Engineering Experiment Station of the University of Illinois. This bulletin gives the results of an extensive series of tests to determine the strength which may be developed in welded joints made by fusing thin steel plates together by means of the flame of an oxy-acetylene blowpipe. It was found that with careful manipulation such a welded joint may be expected to have about 85 per cent. of the strength of the plate material. Considerable information as to methods of manipulation of the oxy-acetylene blowpipe and the proper regulation of the gases is also given in the bulletin. Copies of Bulletin No. 45 may be obtained gratis upon application to W. F. M. Goss, University of Illinois, Urbana, Illinois.

ACME 2¼"x26" COMBINATION TURRET LATHE

The turret lathe owes its origin almost entirely to American invention. The earliest machines were made for the manufacture of the parts of sewing machines and small arms, and the latest and finest developments have been brought about by the bicycle and motor car industries. With all of the obvious and practical advantages of these machines for reducing the cost of production, it was not until about the year 1890 that they came into use for general manufacturing.



ACME COMBINATION TURRET LATHE.

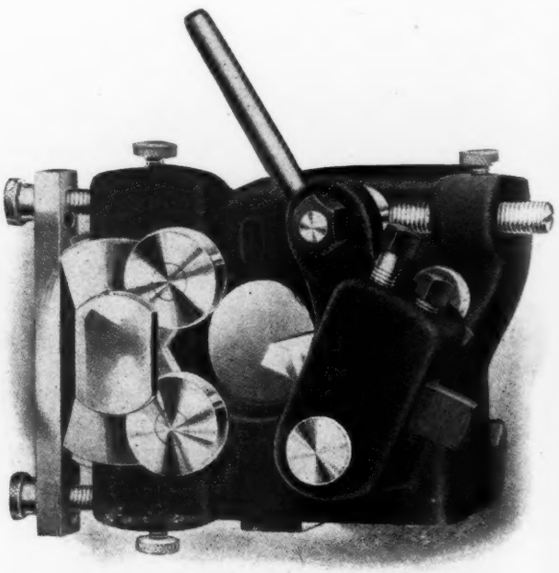
Since that time there have been many fine examples of design in the production of this indispensable tool, and manufacturers of lathes especially in this country have vied with one another to produce a machine which would in every way fulfil the requirements of stability and all-around adaptability. This healthy competition has necessarily resulted in a very high turret lathe development and a remarkable increase in efficiency and operating range.

A prominent recent output in this line, designed for great range and for adaptability in producing work from bar stock, and also from forgings and castings, using simple tools, is the 2¼ in. by 26 in. combination turret lathe by the Acme Machine Tool Co., of Cincinnati, O., which is herein illustrated. As its designation indicates, this machine handles bar work up to 2¼ in. diameter and 26 in. long, with the bar outfit of tools, also forgings and castings to 12 in. diameter, with the chucking outfit. The lathe will swing 19 in. diameter.

There are many points of superior merit embodied in this machine, the majority of which are plainly apparent in the illustration. In particular the design of the bed, which rests on three points, avoiding all twisting action, merits particular attention, as does also construction of the head which is cast solid with the bed, thus insuring great rigidity, and it is provided with friction back gears and three step cones for 3½ in. belt. The spindle is of high carbon hammered crucible steel, and all bearings are ground and hand scraped. The chip pan is made deep, to provide for holding a large quantity of chips. The oil tank is cast solid with the pan and has a perforated cover which serves as a strainer, allowing the oil to drain back into the tank. The oil pump delivers an ample supply of oil and operates when the machine is running in either direction.

The carriage has bearings the full length on the V's, which are of large proportions, and is held securely by gibs at the front and back. Automatic adjustable stops are provided for each turret hole, and four auxiliary stops which may be used in any combination desired, are controlled by the knob seen at the right hand end of the carriage. All of the stops trip the automatic feed.

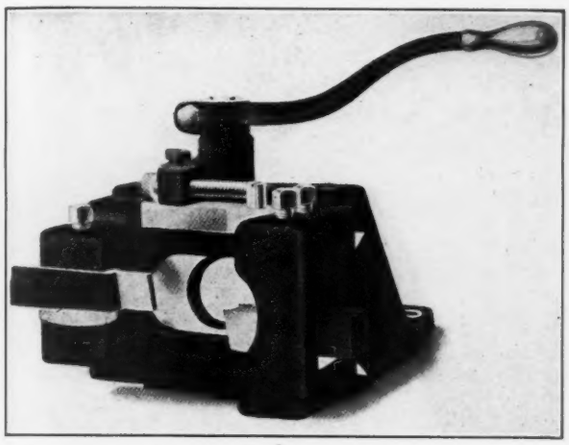
The chuck is specially designed to insure holding the work accurately, together with great gripping power. It is opened and closed while the machine is running by means of the long lever shown at the front of the head, and this lever also operates the roller feed. The important features of this chuck are that the work does not have "end motion" when the chuck is closed, making it possible to do second operation work requiring exact shoulder length, and the jaws do not "overhang," allowing short work to be gripped without tilting the jaws. These latter are easily removed and inserted without dismantling the chuck. A roller feed of improved type is used to feed the stock, and the centering jaws and rolls are operated together automatically. In adjusting the roller feed for any size stock, it is only necessary to turn the spanner wrench until the jaws grip the stock, then loosen a trifle and the rolls will be under the proper tension to feed the stock. Any section of bar can be fed, round, square or hexagon. Three roller rest



ROLLER REST TURNER.

turners, as illustrated, are furnished with the equipment for bar work. These turners are adjustable from 2¼ in. to ½ in. diameter stock. The cutter is of high speed steel and both cutter and back rests can be quickly withdrawn to pass over a large diameter without changing the size the tool is set for.

The turret consists of a circular plate with radial locating slots for the tools, also bolt holes for clamping them to the top of the turret. It is mounted on a cross slide of generous proportions. The turret locking bolt is placed at the front end of the slide directly under the cutting tool, and works in hardened and ground taper bushings let into the solid turret. This construction has been adopted as giving the most rigid tool support, the pressure of the cut being downward, resulting in a support which is practically solid. The cross slide moves on a narrow dove-tail guide with a gib for taking up wear, and



THE SLIDE TOOL.

has hand and power cross feed in both directions, with large micrometer dial. Independent micrometer stops are provided for each tool on the turret. These stops are convenient to the operator; they can be used in any combination desired, and are arranged to trip the automatic feed. A very rigid stop is used to locate the turret in its central position, all movement of the cross slide being from the center out. Power feed is provided for both the cross and longitudinal movement of the turret. It is of the geared type, giving four changes, which are instantly obtainable by moving the lever shown at the front of the head. Both feeds are reversible by means of the lever at the front of the feed box.

The slide tool, also illustrated, for holding cutting off and forming tools, will be found very convenient. The cutting off tool is placed at the rear as shown, so that the machine need not be reversed to use either tool. All working parts of the machine are carefully protected from dirt and chips, thus insuring accuracy in the output. The floor space is 3 ft. by 9 ft. 3 in., and the net weight is 3,800 lbs.

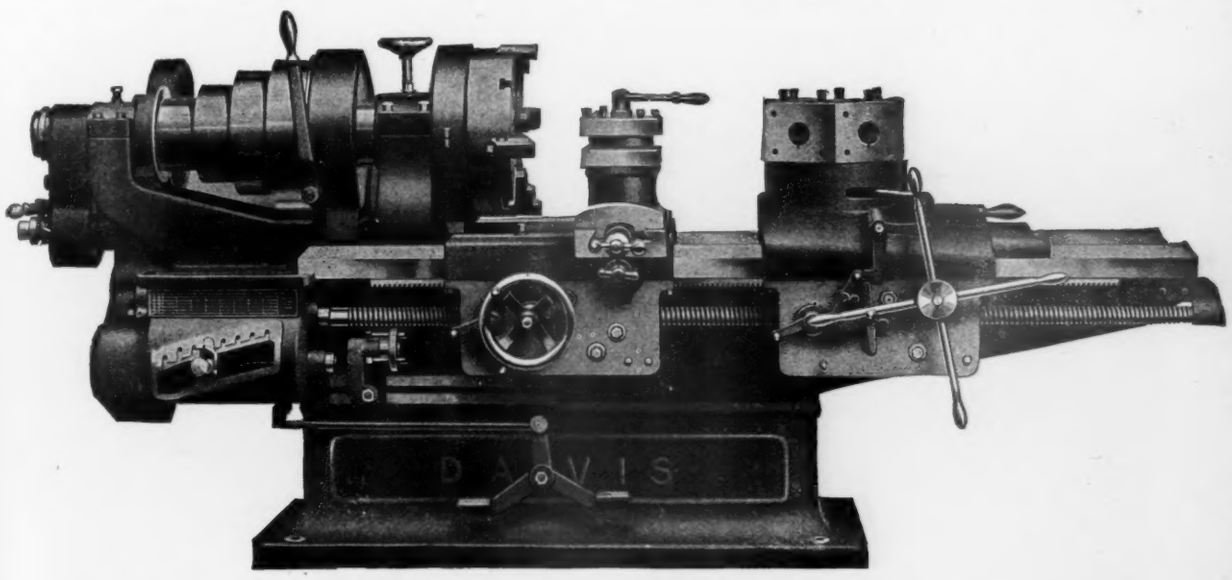
TURRET BORING, FORMING AND TURNING LATHE

As an example of a remarkably efficient turret boring, forming and turning lathe, the new machine by the W. P. Davis Machine Co., of Rochester, New York, claims particular attention. It embodies many interesting features and finely wrought details which easily place it in the front rank of the prominent machine tools of the year.

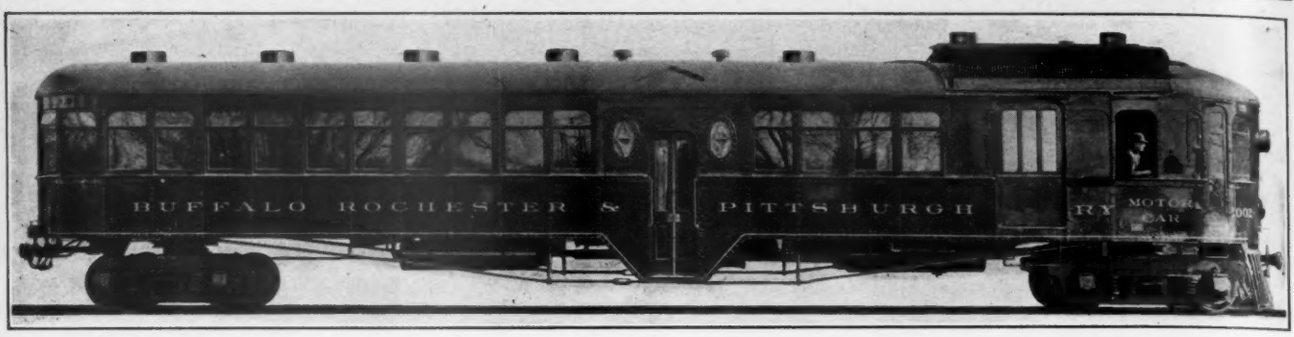
This lathe has a geared friction head and has positive drive with the back gears. The triple gear meshes into the face plate when desired. The spindle is made of special steel and has a special 18 in. 4-jaw independent chuck. The cone has four steps, and this in connection with the two-speed countershaft and the back gears gives a wide range of speeds and feeds. A change from one feed to another or a change in threads is permitted almost instantly by the quick change gear box. There are 32 changes possible, ranging from 2 to 32 threads per inch, and special or fractional threads may be cut by changing the end gears. The index plate is so simple that it can be operated without trouble or mistakes.

The saddle on which the turret is mounted is of exceptionally rigid and substantial construction. It is 25 in. wide, has a bearing of 30 inches on the bed, and a travel of 40 in. The hand feed is operated by a pilot wheel and the saddle is also supplied with power feed, having 16 instantaneous changes, and reversible by means of a foot lever on the front of the machine. This can be used for thread cutting. The turret is 15 in. from face to face, 6 in. high and has 6 faces, 6 x 8½ in., with holes 2½ in. diameter. The faces have four holes for attaching forming tools and are made with a key seat and key to prevent boring bars from turning. The turret has a locking device for holding the various faces in line with the spindle, and an open center allows the mandrel to be passed entirely through. An automatic stop is provided for each face, and any face can be tripped at any point desired on the length of the bed.

Hand and power feed are provided for the carriage, and an automatic stop for the longitudinal feed. The four-sided tool post, which can be revolved so that four different tools can be used without changing, is mounted on a cross slide of the carriage, and is supplied with power cross feed. Both the carriage and turret saddle are driven by a lead screw, so that either may be used for thread cutting.



Special attention has been paid to all minor details in the design. The boxes are made of the best quality of genuine babbit, compressed and bored, and have ample oiling facilities. The countershaft has two friction pulleys which are dust proof and self-oiling, as are also the hangers, with a bushing containing a recess for oil. The floor space occupied is 48 x 144 in. and the net weight 7,000 lbs.



GAS-ELECTRIC MOTOR CAR

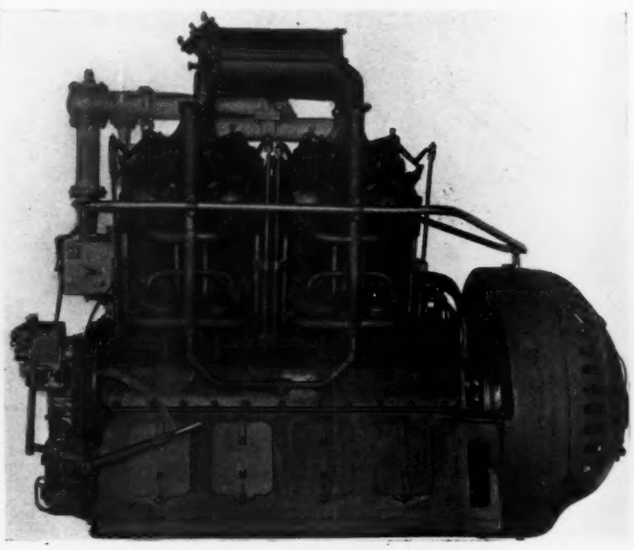
BUFFALO, ROCHESTER & PITTSBURG RY.

For several years the General Electric Company has been actively engaged in the development of the gas-electric motor car, which in its present perfected form is herewith illustrated. As no mechanical transmission exists between the engine and the axle the gas engine may be operated at its maximum efficiency without reference to the speed of the car. The electric power generated by the engine is applied to standard railway motors and operation is by means of a suitable controller in a manner similar to the practice followed in ordinary electric trolley cars. The entire arrangement of mechanism in its engine compartment constitutes a remarkable illustration of a complete and exceedingly compact power plant.

A storage tank of 100 gallons capacity supplies sufficient gasoline to carry the car over 200 miles. On its trip of delivery to the Buffalo, Rochester and Pittsburg Railway the trip of 244 miles from Schenectady to Rochester, via the Auburn division, was made on time at every point, and without delay of any kind. The smoothness of operation and easy control were subjects of the most favorable comment by the party of prominent officials of the New York Central lines who made the trip, and the speed attained on the heavy grades of the Auburn road were highly satisfactory.

The car is 66 ft. long, 14 ft. 1 in. high, and has a seating capacity of 49 in the passenger compartment and 20 in the smoking compartment, with two passengers per seat. The seats are sufficiently wide to accommodate three persons, if desired, and under such arrangement the passenger compartment will accommodate 69, and the smoking compartment 28. It will be noted in the design that the side door construction has been embodied which permits an exceedingly handsome observation end which is also encircled by a continuous seat. Automatic and straight air brakes are provided in addition to the auxiliary hand brake in case of emergencies. The car is also equipped with standard automatic air signals.

PASSENGER COMPARTMENT, LOOKING FORWARD.



GAS ENGINE GENERATING SET.

EDITOR'S NOTE.—For other motor car articles in this journal, see the following references:

Beach Storage Battery Car	April, 1911,	p. 150
Gas-Electric Motor Car, General Electric Co	Feb., 1910,	p. 66
Gasolene Motor Car, Fairbanks, Morse & Co	Nov., 1909,	p. 460
Steam Motor Car, Am. Loco. Co	Aug., 1908,	p. 293
Strang Gas-Electric Motor Car	July, 1908,	p. 256
Ganz Steam Motor Car, Intercolonial Ry	Nov., 1907,	p. 445
Ganz Steam Motor Car, Erie R. R	Aug., 1907,	p. 312
Steam Motor Car, Canadian Pacific Ry	Sept., 1906,	p. 333
Steam Motor Car, Canadian Pacific R'y	Aug., 1906,	p. 294
Union Pacific R. R., Gasolene Motor Car	May, 1906,	p. 187

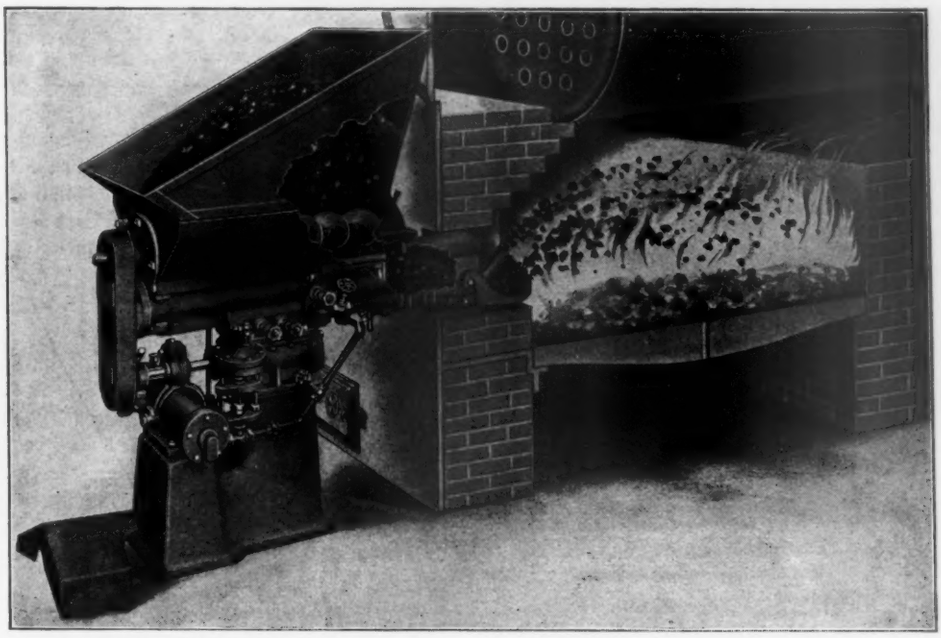
STEEL UNDER BODIES FOR MAIL CARS.—Railway post-office cars with all-steel under-frames will be required by the Post-Office Department after July 1. This arrangement was effected at a conference between Postmaster-General Hitchcock and a delegation of railroad officials. It was agreed that the proposed construction was the best to be used in the period of transition between the all-wood and the all-steel railway mail car.

A PROPOSITION TO INVEST ONE DOLLAR to save ten is frequently less attractive than a proposition to invest ten dollars to save one, because it is unconventional.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

THE "ERIE" STOKER

The stoker shown in the illustration is a self-contained machine, complete in itself, without any auxiliary apparatus, and is particularly applicable to stationary boilers rated up to 250 h.p. and to small and medium size power plants. It is of the overfeed plunger type and is applied to the exterior of the boiler, not interfering with the existing conditions within the firebox.

This stoker consists of the following essential parts: A coal hopper with opening in the bottom at the end nearest the boiler; a conveyor for agitating or carrying the coal from the rear of the hopper to the opening at the front of the hopper, where it falls by gravity in front of the plunger, thus assuring a uniform delivery of fuel, and a main cylinder and trough in which reciprocates a piston and plunger, which, with a variable stroke, throw the coal to the different parts of the firebox. This variable stroke is given to the plunger by means of a rotary valve, two separate steam ports leading from this valve to the rear end of the cylinder, and two choke plugs, one from each of the steam ports. The office of the two choke plugs is to



vary the amount of steam reaching the rear end of the cylinder through the various ports, and thereby give a variable stroke to the plunger. The valve operates in a rotary manner, each of the ports stopping full open in front of its corresponding steam passage in regular succession. The conveyor is controlled by a small reciprocating steam motor which also operates the valve that controls the speed of the piston or plunger, thus giving a uniform amount of coal for each stroke of the plunger. The deflector which is attached to the front of the trough is so designed as to spread the coal to the sides of the furnace as it is delivered by the plunger. The exhaust steam from the motor passes over the deflector, thus assisting the distribution of the coal to the front corners of the firebox. This combination of deflector and exhaust steam absolutely assures even distribution of the coal over the entire grate surface. Each stoker is equipped with an automatic regulator which maintains a constant steam pressure by regulating the amount of coal fed, thus effecting a great saving in fuel.

No portion of the stoker is exposed to the effects of the heat and it is particularly to be noted that the stoker is located between the two fire doors and consequently if there is a breakdown it is a simple matter to hand fire until it is fixed. As a matter of fact, however, the stoker is so extremely simple in its method of construction that the probability of a breakdown is very remote.

It is the ultimate purpose of the Erie Foundry Co., Erie, Pa., to re-design this stoker with a view to adapting it to locomotive practice, but the demand for stationary boilers has been so large that the development of the locomotive type has necessarily been postponed.

OILDAG

Graphite has always been recognized as possessing great merit as a lubricant, but much difficulty has been experienced in arranging for a suitable carrier to get it positively and properly to the bearing surface since ordinary graphite will not remain in suspension in any of the good lubricants. Dr. Edward G. Acheson, however, has finally been successful in solving the problem and has been able to produce a deflocculated graphite which will remain in suspension in oil for any length of time. This mixture has been given the name of "Oildag."

In making this deflocculated graphite an electric furnace is employed and the process is carried on at a temperature which vaporizes every impurity, leaving entirely pure graphite. The particles of graphite resulting are so fine as to be invisible to the naked eye and it is stated that it would take 125,000 of them placed side by side to reach an inch. It will pass through the finest filter paper. This material is mixed with a high grade oil and proves practically a perfect lubricant, not being subject to evaporation or oxidizatoin. It is claimed that one gallon of this material will easily do the work of three gallons of oil and that in two large power stations in New York City the consumption of cylinder oil has been reduced more than 60 per cent. through the use of "Oildag." It would appear that this lubricant is one unusually well suited for locomotives and cars, particularly in view of the well-known effect of graphite on bearing surfaces in giving them a very high polish and almost self-lubricating qualities.

This material is being handled by the International Acheson Graphite Co., Niagara Falls, N. Y.

TO REMOVE PAINT FROM IRON, take lime and mix with common lye into a thick paste by the addition of water, and apply over the surface with a mason's trowel to a thickness of about ⅛ in. After allowing the mixture to remain a short time, wash off with a hose, and most of the old paint will be entirely removed, the remainder being easily scraped off. If the iron has several coats of dried paint, two or three applications will be necessary before the entire surface is clean.

MEN WANTED

CAR DRAFTSMAN.—On eastern railroad, experienced draftsman 10r work on steel passenger and freight car design. Address M. R. W., care AMERICAN ENGINEER.

CAR DRAFTSMAN.—Must be experienced in general car design and in detail work. Location in eastern city. Address L. J., care AMERICAN ENGINEER.

POSITIONS WANTED

A GRADUATE from a leading technical college, having degrees in both mechanical and electrical engineering, has completed four years' apprenticeship in machine shop and two years as machinist in locomotive repair shops and desires any engineering position offering advancement. Age 26. Can furnish substantial references. Address J. S. T., care AMERICAN ENGINEER.

SUPT. OF CONSTRUCTION, INSTALLATION ENGINEER, ENGINEERING SALESMAN, INSPECTOR.—Graduate in mechanical engineering, later special student in electrical engineering; over ten years' experience, East and West; railroad work, from shops to Assistant Engineer; experience with large engineering works and with consulting engineers. Installation, erecting, testing of machinery; steam or hydro-electric power plants, shops and mills, electric traction, irrigation pumping plants. Plans and estimates furnished. Address H. K. J., care AMERICAN ENGINEER.

BOOK NOTES

Principles of Scientific Management. By Frederick W. Taylor, M.E., Sc.D. 144 pages. Cloth. Published by Harper and Brothers, New York. Price, $1.50 net.

In the introduction of this work the author states that it has been written for three reasons:

First—"To point out through a series of simple illustrations the great loss which the whole country is suffering through inefficiency in almost all of our daily acts.

Second—"To try and convince the reader that the remedy for this inefficiency lies in systematic management rather than in searching for some unusual or extraordinary man.

Third—"To prove that the best management is a true science resting upon clearly defined laws, rules and principles as a foundation and, further, to show that the fundamental principles of scientific management are applicable to all kinds of human activities, from our simplest individual acts to the work of our great corporations, which call for the most elaborate co-operation and, briefly, through a series of illustrations to convince the reader that whenever these principles are correctly applied, results must follow which are truly astonishing."

If there is any one capable of clearly demonstrating the principles and practical value of scientific management it is Mr. Taylor, who is largely the originator of the idea, and who has spent over thirty years in study and practice along these lines. The results he has actually obtained under many varying conditions and in many different classes of work give him a position of authority exceeded by none. In this book he treats the subject in a very clear, interesting style, taking each phase of the general principles separately and discussing it clearly and logically, driving the points home by means of well selected, actual examples, taken from his own experience.

To any one unfamiliar with the general principles of scientific management or of Mr. Taylor's methods, this book will give a much clearer idea of the general subject than any work heretofore published, since it follows its title and deals with principles without confusing them with lengthy discussions of their application.

Heat. By J. Gordon Ogden, Ph.D. Cloth, 118 pages, 4½ x 6½. Illustrated. Published by Popular Mechanics Co., Chicago. Price, 25c.

The book consists of a series of articles, each complete in itself, yet all pertaining to heat and its relation to modern mechanics. It is one of a series of handbooks on industrial subjects being published by the above company and is "written so you can understand it." It is a valuable little treatise and may be regarded as a useful addition to any mechanical library.

Proceedings of the International Railroad Master Blacksmiths' Association. Eighteenth Annual Convention. Held at Detroit, Mich., August 16, 17 and 18, 1910. Cloth, 284 pages, 5½ x 8. Secretary, A. L. Woodworth, C. H. & D. R. R., Lima, O.

Although the papers presented at this convention were unusually brief it is quite evident that what was lost in length was more than compensated for in strength. This was well borne out by the extended discussion which followed in the instance of practically every subject presented. There is no need to add that this is exactly as it should be. The true test of the value of any convention is best determined by the interest taken by those in attendance, and their participation in the proceedings The Master Blacksmiths' Association is to be congratulated on its selection of subjects of such timely interest that comment followed as a logical result. The principal papers presented were on Tools and Formers, the Development of Railroad Frogs and Switches, High Speed Steel, Frame Making and Repairing, Oxy-Acetylene Welding, and Spring Making and Repairing. The book is complete with these valuable papers and the discussions, and is unusually well illustrated with half-tones and line drawings.

Power. By Charles E. Lucke, Ph.D. Cloth. 304 pages. 5 by 7½ inches. Illustrated. Published by the Columbia University Press, New York, N. Y.

The object of the series of lectures included in this volume is to point out the enormous effect that the substitution of mechanical power for hand and animal labor has had on the organization of society and the conditions of living, and by presenting the development of power machinery to show what sort of ideas have produced this result. The bulk of the subject matter accordingly is concerned with the apparatus and machinery for the converting of natural energy in any of its available forms into useful work, together with the physical processes for the execution of which that apparatus was devised. The book is well illustrated with over 200 half-tones and line drawings, and is extremely valuable in its historical aspect.

The Supply Department. By H. C. Pearce. Cloth. 112 pages. 5½ by 9 inches. Published by the *Railway Age Gazette*, 83 Fulton street, New York, N. Y.

This book from the pen of the general storekeeper of the Southern Pacific Co. is the first of its kind ever published, and as such will no doubt be widely read by those identified with this important branch of ralroad service. The work treats successively on purpose and organization, duties of officers, general and division stores, requisitions, handling, and all pertaining to supply department work. Several of the chapters are illustrated by organization charts, storehouse floor plans, and order, requisition and statement forms.

Scientific Management and Railroads. By Louis D. Brandeis. Cloth. 92 pages. Published by the *Engineering Magazine*, 140 Nassau street, New York, N. Y.

On January 3, 1911, Mr. Brandeis submitted to the Interstate Commerce Commission a brief in which the evidence introduced at earlier hearings on the possibilities of economies, which could be attained by the introduction of scientific management, was referred to and discussed. About one-half of the brief related

to the latter subject, and this part is now reprinted in the present volume.

Engineering Index Annual for 1910. Published by *The Engineering Magazine*, New York, N. Y. Cloth. 496 pages, 6 x 9 inches.

The present volume of this valuable publication, which is the ninth since the work was first undertaken, and the fifth since it assumed the annual form, represents the continuation of that originally started by the late Professor J. B. Johnson in the Journal of the Association of Engineering Societies in 1884, and turned over by that association to the *Engineering Magazine* at the close of 1895. Its addition to the previous volumes, published in 1892, 1896, 1901, 1906, 1907, 1908, 1909 and 1910, makes available to the reader a continuous index to the engineering and technical literature of the past twenty-six years. With each succeeding issue additional care has been exercised to meet the convenience of the users of the book, and especially to facilitate its use in libraries by those who are not accustomed to refer to it month by month, and hence are not wholly familiar with the arrangement. So well known and indispensable has this work become to engineers, superintendents and managers, that to comment on its scope and usefulness would probably be superfluous, but sufficient to say it incorporates references to practically every article of value that has appeared in any of the scientific or technical magazines during the past year. Its comprehensive scope is well indicated by the list of periodicals included. This comprises about two hundred and fifty publications, representing seventeen nations and colonies and six languages. The value of this work to the engineer who necessarily must make frequent search of the past files of technical periodicals is incalculable, and his library cannot be complete without its addition.

PERSONALS

WM. QUEENAN has been appointed car shop foreman of the Chicago, Burlington & Quincy Railroad at Aurora, Ill.

GEORGE WORLING has been appointed master mechanic of the Gainesville Midland Ry., with office at Gainesville, Ga.

GEO. DURHAM has been appointed master mechanic on the Delaware, Lackawanna & Western R. R. at Scranton, Pa.

D. M. KNOX has been appointed to succeed W. H. V. Rossing as mechanical engineer of the Missouri Pacific system.

C. E. GOSSETT has been made master mechanic of the Minneapolis & St. Louis, Ry., with headquarters at Minneapolis, Minn.

N. KIRBY has been appointed master mechanic of the Alabama, Tennessee & Northern R. R. at Panola, Ala., vice D. D. Briggs.

T. KILPATRICK has been appointed general foreman at the Cedar Rapids, Ia., shops of the Rock Island Lines, succeeding J. M. Whalen, resigned.

EDWARD HUGHES has been appointed purchasing agent of the Lehigh & New England R. R., with office at Lansford, Pa., vice J. B. Whitehead, resigned.

W. H. SNYDER, general foreman, mechanical department, of the Tonopah & Goldfield Ry., at Goldfield, Nev., has had his title changed to master mechanic.

GEORGE MCQUAID has been made general foreman of the Chicago, Rock Island & Pacific Ry., at Eldon, Ia., vice R. J. McQuaid, transferred to Rock Island, Ill.

A. L. MCNEIL has been appointed assistant purchasing agent of the Chicago & Alton Ry., and the Toledo, St. Louis & Western R. R., with office at Chicago.

B. RICHARDSON has been made superintendent of motive power of the Duluth & Iron Range R. R., with office at Two Harbors, Minn., vice R. B. Moore.

H. D. JACKSON has been appointed master mechanic of the Charlotte Harbor & Northern Railway, with headquarters at Arcadia, Fla., vice S. B. Smith, resigned.

JOHN RYAN has been appointed superintendent of the fuel department of the Missouri, Kansas & Texas Ry., with office at Pittsburg, Kan., succeeding John Jopling, deceased.

GEORGE E. CHESSFORD has been appointed master mechanic of the Chicago, Milwaukee & Puget Sound Ry., at Miles City, Mont., succeeding A. V. Manchester, resigned.

C. J. DRURY has been made master mechanic of the Santa Fe at Amarillo, Tex., vice W. J. Hill, transferred to succeed Mr. Drury at Arkansas City, Kan., as master mechanic.

FRED RENTCHLER, formerly with the Wabash R. R. at Moberly, Mo., has been appointed general foreman of boiler work for the St. Paul & Des Moines Ry. at Des Moines, Iowa.

F. W. STUBBS succeeds John R. Thompson as mechanical engineer on the Chicago Great Western Ry. at Oelwein, Ia., Mr. Thompson having been appointed master mechanic at Clarion, Ia.

A. N. WILSIE has been appointed master mechanic of the Omaha division of the Chicago, Burlington & Quincy R. R., with headquarters at Omaha, Neb., succeeding E. D. Andrews, resigned.

W. H. V. ROSSING, mechanical engineer of the Missouri Pacific system, has been appointed assistant to Vice-President Nixon of the Frisco lines, with jurisdiction over mechanical matters.

J. M. JAMES, master mechanic at Olean, N. Y., Pennsylvania, Railroad, has been transferred in a similar capacity to West Philadelphia, Pa., succeeding J. C. Mengel, transferred to Altoona.

J. C. MENGEL, master mechanic at the West Philadelphia shop, has been transferred in a similar capacity to the Altoona machine shop, Pennsylvania Railroad, succeeding I. D. Thomas, promoted.

J. M. HENRY, master mechanic on the Pennsylvania Railroad at Sunbury, Pa., has been transferred in a similar capacity to Olean, N. Y., succeeding J. M. James, transferred to West Philadelphia, Pa.

J. B. ELLIOTT, master mechanic of the Baltimore & Ohio R. R., at Newcastle Junction, Pa., has been appointed master mechanic at the Glenwood shops, Pittsburg, succeeding J. F. Prendergast, resigned.

A. M. DARLOW, round house foreman of the Chicago & Eastern Illinois R. R., at Danville, Ill., has been appointed mechanical engineer of the Buffalo & Susquehanna Railroad, with office at Galeton, Pa.

E. E. MULLINS, mechanical engineer of the Northern Railway Company, Costa Rica, has been appointed superintendent of motive power, with office at Limon, Costa Rica, succeeding W. H. Sample, resigned.

T. F. UNDERWOOD, roundhouse foreman on the St. Louis & San Francisco Ry. at Springfield, Mo., has been transferred to Monett, and J. E. Burke of the latter point, takes Mr. Underwood's place at Springfield.

E. F. ESSICK, master mechanic of the Saginaw division of the Pere Marquette Ry., has been transferred to Ludington, Mich., and is succeeded by C. J. Shudder, who is promoted from foreman of the Saginaw shops.

S. H. DRAPER, general air brake inspector of the Northern Pacific R. R. at St. Paul, Minn., has been appointed master mechanic of the Rocky Mountain division, with office at Missoula, Mont., succeeding Silas Zwight, promoted.

E. J. MYERS has been appointed to succeed John McKeown, retired, as foreman boilermaker at the Galion, O., shop of the Erie Railroad. Mr. McKeown retires after many years' service, the greater part of which was in connection with the Galion shop.

J. LOWELL WHITE has been appointed assistant purchasing agent of the New Orleans, Texas & Mexico Ry.; the Beaumont, Sour Lake & Western R. R.; the Orange & Northwestern Ry., and the St. Louis, Brownsville & Mexico R. R., with office at Houston, Texas.

H. P. MEREDITH, assistant engineer of motive power in the office of the general superintendent of motive power, Pennsylvania Railroad, at Altoona, Pa., has been appointed master mechanic, with office at Baltimore, Md., succeeding Eliot Sumner, transferred to Sunbury, Pa.

I. D. THOMAS, master mechanic at the Altoona, Pa., machine shops of the Pennsylvania Railroad, has been promoted to superintendent of motive power of the Erie division of the Pennsylvania Railroad and the Northern Central Railway, with office at Williamsport, Pa., succeeding J. T. Wallis, promoted.

H. M. CURRY, general master mechanic of the Northern Pacific lines east of Mandan at St. Paul, Minn., has been appointed mechanical superintendent, with office at St. Paul, succeeding William Moir, retired after having been with the company for almost thirty years. Silas Zwight, master mechanic at Missoula, Mont., succeeds Mr. Curry.

CATALOGS

FREIGHT, BAGGAGE AND EXPRESS HANDLING.—The Automatic Transportation Company, of Buffalo, N. Y., has published an illustrated pamphlet descriptive of its electric truck, which has been specially designed and constructed for handling package freight at railway and steamship terminals, and in fact all institutions which require trucking about the premises. The truck operated by storage batteries weighs 1,800 pounds and will carry from 2,000 to 4,000 pounds.

GAS ENGINES.—The Mesta horizontal double-acting four-cycle gas engine is described and illustrated in a new catalog issued by the Mesta Machine Company, of Pittsburg, Pa. This company does not build what are termed small gas engines, their smallest size being about 400 horsepower, but they turn out all sizes from that up to the largest engine used. The present catalog contains some well executed half-tones, suppelmentary to the descriptive matter, and concludes with a very interesting and instructive comparison between gas versus steam power.

GRAPHITE LUBRICATION.—A booklet has just been issued by the International Graphite Company, of Niagara Falls, N. Y., which reproduces the very interesting and instructive address on the above subject which was delivered by Dr. Edward G. Acheson before the Automobile Club of America, May 17, 1910, and before the National Gas and Gasoline Engine Trades Association, Cincinnati, O., June 14, 1910. This little book is of great value to users of graphite and to those interested in the subject and it will well repay a careful perusal.

SILICA-GRAPHITE PAINT.—The Josepn Dixon Crucible Company, of Jersey City, N. J., has just published a very neat folder entitled "Maintenance Painting for Electric Railways." It gives excellent photographs of street railway viaducts, power plant stacks, and car trucks painted with Dixon's silica-graphite paint. The folder explains in a very interesting way the special adaptability of this paint for street railway uses, and the Paint Department of that company will be glad to send copies to anyone interested in economic railway maintenance.

ASPHALT MASTIC FLOORS.—Under the above title the American Asphaltum & Rubber Co., of Chicago, Ill., has issued a handsomely illustrated catalog showing several installations of this waterproof, acid proof and sanitary flooring which, has been adopted by some of the largest business concerns in the country. This floor has safely passed from the experimental stage, as the first one was laid down some twelve years ago. Reports on floors which have been used for a much longer period than the guaranteed five years indicate that they are still in a good state of preservation.

STEAM ENGINEERING SPECIALTIES.—In its new catalog No. 10, issued by the Wm. Powell Co., Cincinnati, O., much time and thought has been expended to make it readily understood and comprehensive to the prospective buyer. With this end in view all the articles have been re-figured, and the intention is to retain these in all subsequent catalogs. The articles are consecutively numbered, and these numbers are placed at the top of each page beside the page numbers, thereby rendering it unnecessary to refer to the index to locate the figure numbers. The catalog is a substantially bound book of 287 pages and contains a supplement of valuable tables and useful information, compiled by the late James Powell. It is requested that all previous issues of the catalog be destroyed, and that orders be placed by figure numbers in this new "No. 10" catalog.

NICKEL-CHROME CHILLED CAR WHEELS.—The advantages of this wheel, as demonstrated by very complete service tests on the Pennsylvania Railroad, have been presented in a very interesting pamphlet just issued by the Nickel-Chrome Chilled Car Wheel Company, Frick Bldg., Pittsburgh, Pa. In the general description of the wheel and of the tests, the fact is emphasized that nothing has been added to the ordinarily employed mixture to increase its strength, the only advance made by car wheel manufacturers being in the employment of metallurgists to analyze the scrap car wheels and other mixtures now in use, in order to insure a more uniform mixture. The effect of nickel and chrome is to so modify the chilled surface of the tread as to toughen it, and give greater mileage, and the results of the various tests are conclusive in indicating the attainment of the desired end. The pamphlet will repay an attentive perusal.

STEEL MINE TIMBERS.—The Carnegie Steel Co., of Pittsburg, Pa., has recently published a book of data and tables for mining engineers, and a well illustrated album showing the types of construction and examples of installation of steel mine timbers. The substitution of steel for wood for this purpose avoids all those elements of economic waste to which timber is liable, particularly waste in framing and fitting, waste from destruction by decay or insects, and more than all, waste by fire; to which may also be added that the use of steel within the mines means less excavation, better ventilation, less erection cost and greater endurance. These two books constitute valuable additions to existing literature on mine engineering. The first mentioned contains a number of working sketches showing the application of steel for gangway supports and mine props. Some 28 pages are devoted to the presentation of very complete data tables covering safe load in pounds for both steel and the various wooden timbers.

NOTES

JOSEPH DIXON CRUCIBLE CO.—Sherman Paris has succeeded H. S. Snyder in the advertising department of the above company.

NATIONAL BOILER WASHING CO.—Announcement is made by this company, of Chicago, Ill., of office removal in the Railway Exchange from No. 1707 to No. 529.

UNDER-FEED STOKER CO. OF AMERICA.—This company announces the removal of its general offices to the Harris Trust Building, Monroe street, between Clark and La Salle, Chicago, Ill.

CHICAGO-CLEVELAND CAR ROOFING CO.—Announcement of the removal of offices has been made by this company, from 720 Old Colony Building, where it has been located for seventeen years, to 427-429 People's Gas Building, Chicago, Ill.

BURTON W. MUDGE & CO.—Announcement has been made that Thomas H. Garland has been elected as a director of the company. Mr. Garland is the inventor of the Garland Car Ventilator, which is manufactured and sold exclusively by Mudge & Company.

HOMESTEAD VALVE MFG. CO.—This company announces the appointment as its agents in Louisville and vicinity, the E. D. Morton Co., who will carry a stock of Homestead valves and will be ready at all times to supply the trade in that city and adjacent territory.

TRANSPORTATION UTILITIES CO.—Reuben C. Hallett, well known throughout the railroad field, has been appointed to the sales-staff of the recently organized Transportation Utilities Company, direct representatives of the Acme and General Railway Supply Companies of Chicago, with headquarters at 30 Church street, New York City.

AMERICAN STEEL FOUNDRIES CO.—Warren J. Lynch, formerly passenger traffic manager of the New York Central lines west of Buffalo, has been elected to the fourth vice-presidency of the American Steel Foundries Company. Mr. Lynch will make his headquarters at the New York sales office of the company.

J. F. FAESSLER MFG. CO.—This company, of Moberly, Mo., makers of Boss and Universal flue expanders, flue cutters and other boiler tools, has reorganized its sales department and placed Chas. F. Palmer in charge, as sales manager, with office at 810 Olive street, St. Louis. Mr. Palmer is well qualified for this position through previous experience in selling Faessler tools and as representative of the Frank E. Palmer Supply Co. of St. Louis.

WESTINGHOUSE, CHURCH, KERR & CO.—John I. Wallace, formerly Chief Engineer of the Panama Canal, who retired after inaugurating the American work on the canal and afterwards designed the new Chicago & Northwestern passenger terminal at Chicago, which has just been completed at a cost of $25,000,000, has assumed active charge as President of Westinghouse, Church, Kerr & Company, who were the engineers for the new Pennsylvania Railroad station in New York. Among the directors elected at the annual meeting of the company are N. W. Halsey and F. Q. Brown, of New York, George Westinghouse and J. R. McGinley, of Pittsburg, and Homer Loring, of Boston.

RAILWAY STEEL SPRING CO.—The annual report of the Railway Steel-Spring Company, New York, for the year ending December 31, 1910, shows that gross sales were $10,035,435, an increase of $2,192,143 over 1909. The surplus, after fixed charges, was $810,077, or 6 per cent. on the $13,500,000 common stock, as compared with 5.32 per cent. earned on the same stock in 1909. At the annual meeting Otis H. Cutler, president of the American Brake Shoe & Foundry Company, Mahwah, N. J., was elected a director to succeed the late Frank S. Layng. The officers of the company and the other directors were re-elected.

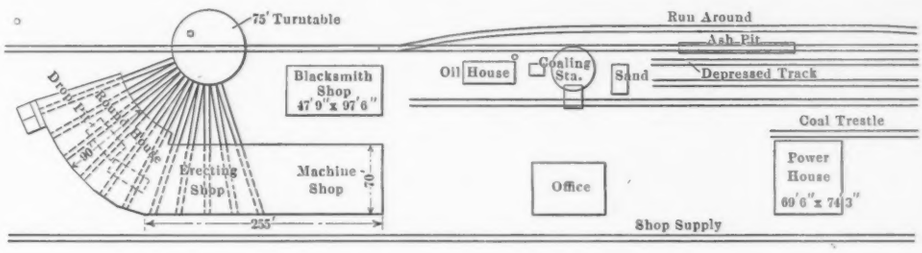
UNIVERSAL VANADIUM CO.—Under the laws of the State of Delaware, the above company has recently been incorporated with the following officers and directors: Edward M. McIlvain, president, 30 Church street, New York, N. Y.; Col. Millard Hunsiker, vice-president, 23 Rue de la Paix, Paris, France; James C. Gray, secretary and treasurer, Frick Building, Pittsburgh, Pa.; Joseph W. De Wyckoff, European representative, 64 Victoria street, Westminster, London, England; E. Marshall Fox, Wetley Rocks, Staffordshire, England, and William McIlvain, Reading, Pa. The Universal Vanadium Company was formed for the purpose of acting as selling agents for the American Vanadium Company in a more comprehensive and effectual manner, and it will act in a selling capacity in conjunction with the Vanadium Sales Company.

SPRAGUE ELECTRIC COMPANY MERGED WITH GENERAL ELECTRIC.—On June 1, 1911, the Sprague Electric Company will be merged with the General Electric Company of Schenectady, N. Y. Its business will be conducted under the name Sprague Electric Works of General Electric Company. The manufacture and sale of the lines of apparatus and supplies heretofore exploited by the Sprague Electric Company will be continued under the same organization, with Mr. D. C. Durland as general manager. All correspondence should be sent to the Sprague Electric Works at the same address as in the past. The main office will be continued at heretofore, at 527-531 West 34th street, New York, N. Y., as will also all branch offices in principal cities.

Locomotive Shops at Cape Charles, Va.

VERY COMPLETELY EQUIPPED SHOPS HAVE RECENTLY BEEN ERECTED AT THIS POINT TO CARE FOR THE POWER OF THE NEW YORK, PHILADELPHIA & NORFOLK RAILWAY, NOW A PART OF THE PENNSYLVANIA SYSTEM.

On the division of the New York, Philadelphia & Norfolk Railway from Delmar south, there are 37 engines at present regularly assigned, and during the busy season, which covers usually about three months, there are about 50 engines regularly on this division. The headquarters for this power is at Cape Charles, the southern end of the road, and new shops have just been put into operation at that point giving facilities for making all repairs, with the exception of heavy boiler work, on the regularly assigned power. Although these shops are relatively small they have been very completely equipped with modern appliances of all kinds, and present an excellent example of a suitable and convenient arrangement for a shop of this size.



GENERAL PLAN OF CAPE CHARLES SHOP.

The machine and erecting shop is enclosed in a brick building 70 by 250 ft., and a six-stall section of the roundhouse forms an extension on one end of this building, as is shown in the plan. With this arrangement the five tracks in the erecting shop are located so as to radiate from the turntable and the necessity for a transfer table is eliminated. While this plan requires slightly more room in the erecting shop it is on the whole an excellent scheme for a shop of this size. The method of operation consists of taking the locomotive into the roundhouse to the drop pits, removing the wheels, placing two shop trucks under the frames and then drawing it on to the turntable and placing it on any pit in the erecting shop. Although no crane has been installed in the machine and erecting shop at present, runways have been provided for a 10-ton crane, which will be installed later. The structure enclosing the machine and erecting shop is most substantial, heavy brick walls and steel roof trusses in a single span. A louve is provided in the center of the roof for the full length of the building and the windows swing on a horizontal axis, being controlled from the floor in sections by a "straight push" sash operator installed by the G. Drouvé Co.

The roundhouse has a span of 90 ft. and the wooden roof truss here employed required the locating a row of posts 25 ft. from the outer circle. The louve in this section of the building is provided with ventilators on both sides. Throughout this structure and the others natural lighting has been given careful attention and the window area is almost the maximum. In the machine shop a plank floor is employed, while the erecting shop and roundhouse have a wooden block floor. The artificial lighting throughout is by mercury vapor lights.

GENERAL VIEW OF THE ERECTING SHOP.

The tools are electrically driven, the larger ones having individual motors, as is shown in the following list:

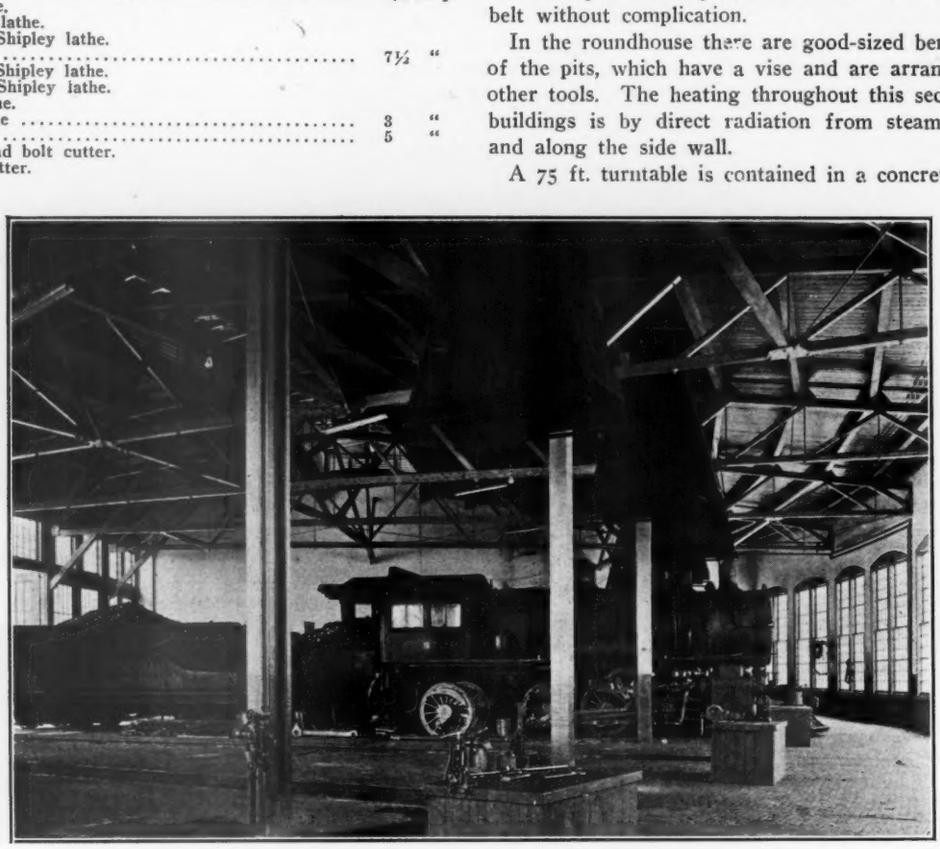
TOOLS.	MOTOR.
Niles planer	7½ h. p.
30 in. American "patented head" lathe	10 "

TOOLS.	MOTOR.
Group	7½ h. p.
16 in. Blair lathe.	
18 in. American lathe.	
18 in. Lodge & Shipley lathe.	
Group	7½ "
18 in. Lodge & Shipley lathe.	
28 in. Lodge & Shipley lathe.	
36 in. Niles lathe.	
Williams pipe machine	3 "
Group	5 "
Acme double head bolt cutter.	
Williams bolt cutter.	
Emery wheel.	

a clear open head space for the crane and liberal length of belt without complication.

In the roundhouse there are good-sized benches between each of the pits, which have a vise and are arranged as lockers for other tools. The heating throughout this section and the other buildings is by direct radiation from steam pipes in the pits and along the side wall.

A 75 ft. turntable is contained in a concrete pit, floored with concrete, and is driven by a McGrath pneumatic turntable tractor manufactured by the Draper Mfg. Co., Port Huron, Mich.

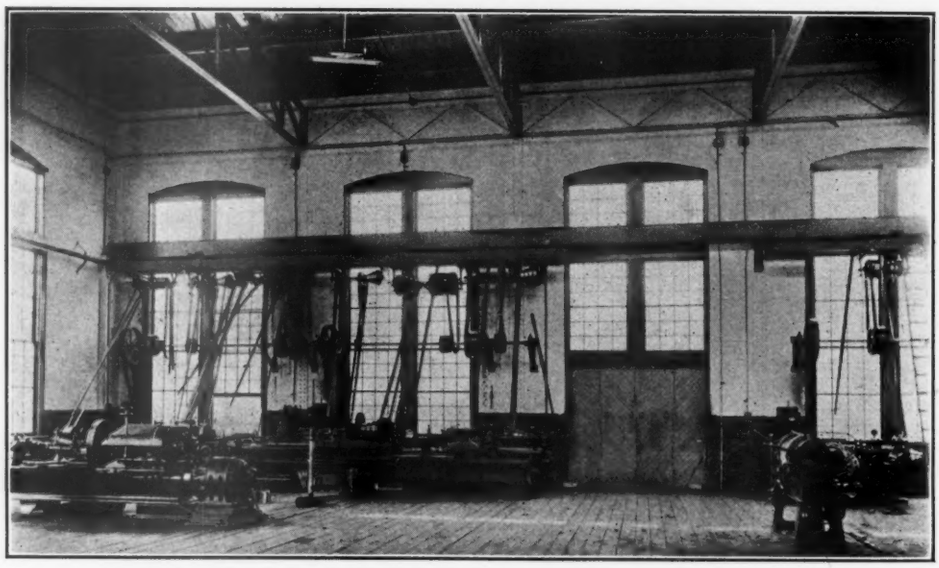


INTERIOR OF ROUNDHOUSE—CAPE CHARLES SHOPS.

TOOLS.	MOTOR.
Bickford radial drill	5 h. p.
Dill slotter	5 "
Group	7½ "
Niles slotter.	
Gould & Eberhardt shaper.	
Brown & Sharpe milling machine	5 "
Group	3 "
Reamer grinder.	
Drill grinder.	

In addition to the space occupied by the machine tools there is a liberal amount of floor area left for benches and the usual

The equipment for boiler and blacksmith shop work is contained in a brick building with a wooden roof truss and cinder floor, measuring 50 by 100 ft., located conveniently as is shown in the general layout. In this building is the following equipment: Flue cutting machine, furnace, welding machine, swedging machine, testing machine and annealing furnace. This group is driven



A CORNER OF THE MACHINE SHOP, SHOWING ARRANGEMENT OF COUNTERSHAFT WITH GROUP DRIVE.

tinsmith, air brake and other bench work equipment is provided. Other tools required, as for instance a driving wheel lathe, boring mill, etc., will be added in the near future. One of the illustrations shows the arrangement of countershaft along the side wall, used in connection with the group drive. This gives by a 7½ h.p. motor. In the opposite corner is a flanging fire with its clamp, and a pair of hand bending rolls; nearby is a hand shear, a Hilles & Jones punch and shear driven by a 5 h.p. motor; a 1,100 lb. steam hammer; a 600 lb. steam hammer, both provided with jib cranes and each served by three open fires.

A large power house supplies light and power for the yards, depot and the offices scattered throughout the terminal. This has been housed in a most attractive building 70 x 75 ft. which contains three 200 h.p. boilers, hand fired, and two 175 k. v. a. three-phase, 60 cycle, 2,400 volt generators, each driven by a 14 x 18 in. slide valve engine. In the fire room there are two fire pumps, each having a capacity of 500 gallons per minute, also boiler feed pumps and general water service pumps in duplicate. A large feed water heater comprises a portion of the equipment. The water supply for the plant is obtained from 40 driven wells near the power house. In the engine room in addition to the generators there is a 20 k.w. motor generator set for exciting and a similar size turbo-generator set used for starting the alternators. The current leaves the power house at 2,400 volts and is transformed by static transformers before entering the various buildings where it is to be used, and it is delivered to the motors at a pressure of 220 volts. In the power house is also the air compressor which has a capacity of 690 cu. ft. of air per minute. Two 25-light mercury rectifier sets have been installed for the current which is to light the yard, the lamps there being for direct current. The switchboard and all equipment throughout the powerhouse is of the highest character and was carefully installed. Space is provided for additional equipment to increase the present capacity by 50 per cent.

A two-story and basement storehouse and office building of 50 x 72 ft. has been constructed. An electric elevator of 6,000 lbs. capacity has been installed in the store section. In this building, as well as in the offices of the various foremen, the light is by tungsten lamps instead of the Cooper-Hewitt mercury lamps generally used. The oil house is 22 x 53 ft. and contains the usual tanks and arrangement for storage and delivery of oil and waste. The ash pits are of the standard Pennsylvania type and coaling is done by a clam shell bucket on a stationary jib crane operated by a steam hoisting engine.

Ample provision for protection from fire is had by means of the 6 in. fire main, in the form of a loop surrounding the plant, supplying the various plugs throughout the yard and the hose reels in the interior of the various buildings. Two 50,000 gallon steel tanks provide the storage and the pressure for ordinary service. Toilet and wash rooms with hot and cold water and expanded metal lockers have been installed throughout the shop for the comfort and convenience of the employees.

RIGID VS. NON-RIGID FREIGHT TRUCKS

W. J. SCHLACKS.

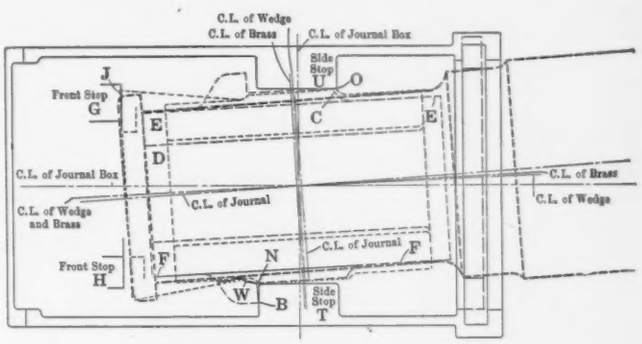
All the recent discussions on rigid vs. non-rigid freight trucks have not called attention as to whether discussions were based on the trucks being rigid or non-rigid in a vertical or a horizontal plane. A few years ago trucks, rigid in the horizontal plane as well as in the vertical plane, had considerable vogue, but there are not very many of them purchased at this time.

The rigid trucks in the horizontal plane were condemned because of the fact that it takes only three points to determine a plane, so that when the fourth wheel found a low spot in the track it was relieved of carrying its proportion of the load because the other three wheels determined the horizontal plane of the truck. We may assume, therefore, that all the recent discussion on rigid or non-rigid trucks is in the vertical plane; that is, whether a truck should be so constructed as to hold the axles perpendicular to the side frames.

The recent excellent report of Prof. Louis E. Endsley of Purdue University * shows that the total movement of some of the non-rigid trucks which ran out of square was as much as 5 61-100 in., half of which, 2 8-10 in., is the amount the truck ran out. Since then trucks have been found with a total movement of 6¼ in. of the side frames, or 3⅛ in. out of square.

To determine the position of the M. C. B. parts, such as brass, wedge and journal in the journal box, and in an effort to determine how much of a part was played by the journal box and contained parts in resisting the trucks running further out of square, the plan view of the journal box and contained parts, with the truck 5¼ in. out of square, is herewith reproduced.

It will be noted that there is not room enough in the M. C. B. journal box for the M. C. B. contained parts, with a truck so far out of square. The distance between the centers of the journals as measured on a line perpendicular to the side frame is reduced about ¼ in., due to the angularity of the axle. This causes the brass to take up the play allowed between the rear of the wedge and the flange on the brass, which forces the wedge towards the front stops. It will also be seen that the wedge laps over the front stop "G" at the point "J" about 1-32 in. The brass laps over the collar of the journal at the point



"D" about 1-16 in. by the side lug on the brass, binding the side stop "T" of the box at point "B." Both wedge and brass bind on the side stop "T" at "N" and "B," and on the side stop "U" at "C" and "O." The lines "EE" and "FF" of the brass are considerably out of parallel with the lines of the journal.

It has been determined from this that a truck would not run so far out of square without something in the journal box yielding, either by springing or breaking, and from the information gained through laying out the drawing as illustrated, it was concluded if these trucks really ran out of square excessively, and if the truck depended on the cramping of these parts to resist its running more out of square, the parts that were called upon to resist this excessive movement must indicate the trouble by excessive wear or breakage. The inspection of a number of these trucks in a high percentage of cars, showed brasses with the lugs broken off, as indicated by the line "W" in the drawing. Some of these trucks seemed to have no other means of holding them square except by the angularity of the journal, causing a binding of the brass and wedge between the side stops of the box, and the binding of the wedge on the front stop "G" of the box. This, if the brass or the wedge or the front stop of the wedge does not break, must cause excessive end wear of the journal collars and brass, and a diagonal wear of the brass or bearing on the journal, all of which must conduce towards increased liability of hot boxes and excessive frictional resistance.

From the number of brasses found with broken side lugs, it is fair to assume that a high proportion of these trucks depend on this resistance in limiting the distance they run out of square. It is interesting to note that on inspection of a large number of cars whose trucks were constructed in a manner that was meant to hold them square, that there was only one brass found with the side lug broken off, and that was on a truck, the spring plank of which was made of two angle irons securely riveted to arch bar columns, and in this truck one of the angle irons had broken, which made of it a flexible truck.

* See AMERICAN ENGINEER, May, 1911, page 192.

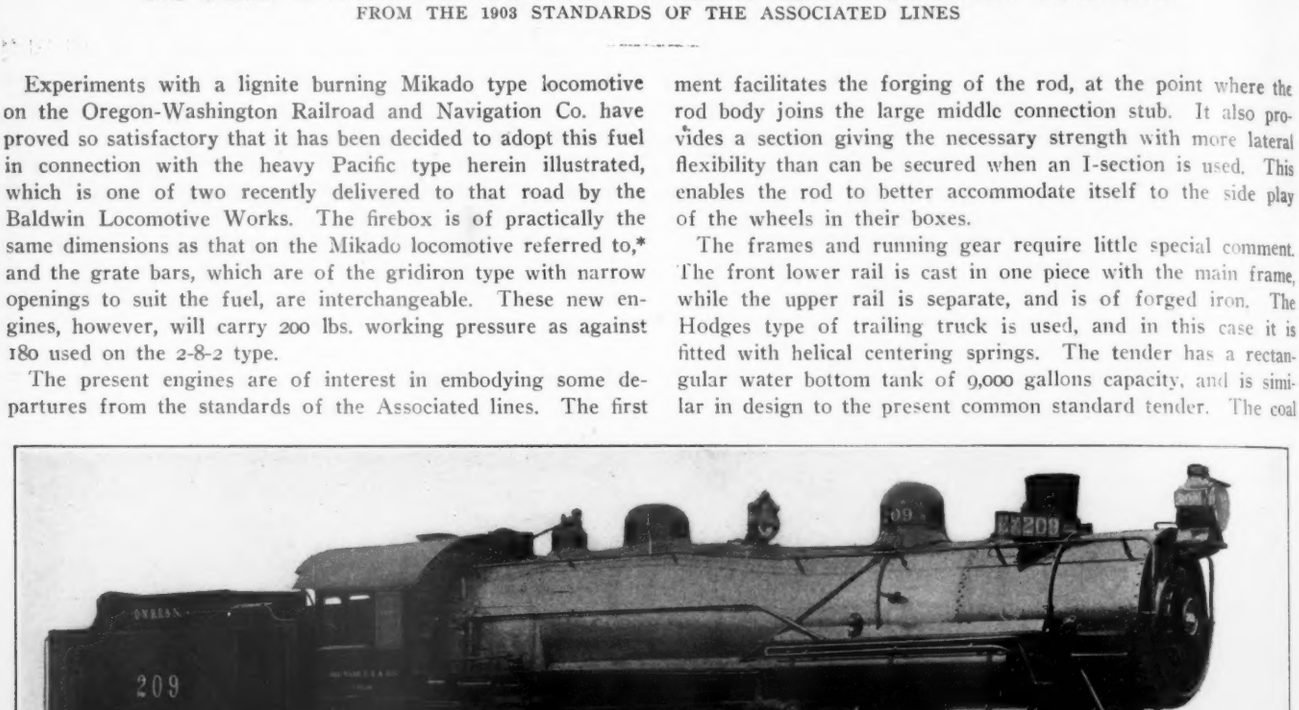
THE CHICAGO & NORTHWESTERN RAILWAY has an extensive spring making department in its smith shop at Chicago. New springs for all the locomotives on the system—1,700 engines—are made and old ones repaired at this plant.

Pacific Type Locomotive Arranged for Burning Lignite

A RECENT ORDER OF TWO HEAVY 4-6-2 TYPE LOCOMOTIVES RECEIVED FROM THE BALDWIN WORKS BY THE OREGON RAILROAD AND NAVIGATION CO. EMBODY SEVERAL DISTINCTIVE DEPARTURES FROM THE 1903 STANDARDS OF THE ASSOCIATED LINES

Experiments with a lignite burning Mikado type locomotive on the Oregon-Washington Railroad and Navigation Co. have proved so satisfactory that it has been decided to adopt this fuel in connection with the heavy Pacific type herein illustrated, which is one of two recently delivered to that road by the Baldwin Locomotive Works. The firebox is of practically the same dimensions as that on the Mikado locomotive referred to,* and the grate bars, which are of the gridiron type with narrow openings to suit the fuel, are interchangeable. These new engines, however, will carry 200 lbs. working pressure as against 180 used on the 2-8-2 type.

The present engines are of interest in embodying some departures from the standards of the Associated lines. The first



NEW LOCOMOTIVE FOR THE OREGON-WASHINGTON RAILROAD AND NAVIGATION CO.

common standard Pacific type locomotive, built in 1903, had a straight boiler, 70 in. in diameter. In the new design the boiler has a wagon top, and measures 74 in. in diameter at the front end, and 85 in. at the dome ring. This engine has also the greatest length of flues, 22 ft., thus far applied by the builders to a 4-6-2 type locomotive. The tubes are spaced with 13/16 in. bridges. The smoke box is 94 inches long and contains an unusually large area of netting.

In further comparison with the first common standard Pacific type locomotive it is noticeable that while the steam pressure, driving wheel diameter and piston stroke remain as before, the cylinder diameter has been increased to 25 in., thus raising the tractive effort from 29,800 to 38,700 pounds. The boiler capacity is proportionally large, as 306 square feet of heating surface are provided for each cubic foot of cylinder volume.

The cylinders are in many respects similar to those used on the previous type, except that they are larger, and have the steam chest centers 4½ in. outside the cylinder centers, so that a satisfactory design of Walschaert gear can be applied. By-pass valves of the Sheedy type are used, in accordance with the regular practice of the Associated Lines for piston valve cylinders. The piston valves are of the built-up type, 15 in. in diameter. The valve rod crosshead guide is supported in front by the steam chest head, and at the rear by the guide yoke. The main guides can thus be adjusted to take up wear, without in any way disturbing the adjustment of the gear.

The connecting rods are of forged open hearth steel, the main rods having an I-section while the side rods are rectangular. The front side rods have a continuous taper in depth, from front to back, while the width remains constant. This arrangement facilitates the forging of the rod, at the point where the rod body joins the large middle connection stub. It also provides a section giving the necessary strength with more lateral flexibility than can be secured when an I-section is used. This enables the rod to better accommodate itself to the side play of the wheels in their boxes.

The frames and running gear require little special comment. The front lower rail is cast in one piece with the main frame, while the upper rail is separate, and is of forged iron. The Hodges type of trailing truck is used, and in this case it is fitted with helical centering springs. The tender has a rectangular water bottom tank of 9,000 gallons capacity, and is similar in design to the present common standard tender. The coal capacity has been increased from 10 to 15 tons. The tender truck wheels, as well as those of the engine truck, are of solid rolled steel, and were manufactured by the Standard Steel Works Co.

These locomotives, with ample weight on driving wheels and high tractive effort, are admirably fitted for the heaviest class of passenger service. The ratio of adhesion is 4.26, which is lower than that frequently found in large Pacific type locomotives, and shows that the weight on driving wheels has been used to the best advantage. At the same time the boiler should be able to meet all demands that may be made upon it. The general dimensions, weights and ratios are given below:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Pass.
Fuel	Lignite
Tractive effort	38,700 lbs.
Weight in working order	265,400 lbs.
Weight on drivers	164,850 lbs.
Weight on leading truck	50,150 lbs.
Weight on trailing truck	50,400 lbs.
Weight of engine and tender in working order	435,000 lbs.
Wheel base, driving	13 ft. 4 in.
Wheel base, total	35 ft. 8 in.
Wheel base, engine and tender	65 ft. 7½ in.

RATIOS.	
Weight on drivers ÷ tractive effort	4.2
Total weight ÷ tractive effort	6.8
Tractive effort × diam. drivers ÷ heating surface	613.15
Total heating surface ÷ grate area	69.42
Firebox heating surface ÷ total heating surface, %	4.83
Weight on drivers ÷ total heating surface	33.91
Total weight ÷ total heating surface	54.60
Volume both cylinders, cu. ft.	.16
Total heating surface ÷ vol. cylinders	306
Grate area ÷ vol. cylinders	4.37

CYLINDERS.	
Kind	Simple
Diameter and stroke	25 x 28

VALVES.	
Kind	Piston
Diameter	15 in.

* See AMERICAN ENGINEER, October, 1910, page 404.

WHEELS.	
Driving, diameter over tires	77 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	33½ in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	45 in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	Wagon top
Working pressure	200 lbs.
Outside diameter of first ring	74 in.
Firebox, length and width	120 x 84 in.
Firebox plates, thickness	F. ½, B. ⅜, S. ⅜ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	356—2¼ in.
Tubes, length	22 ft.
Heating surface, tubes	4,593 sq. ft.
Heating surface, firebox	235 sq. ft.
Heating surface, total	4,860* sq. ft.
Grate area	70 sq. ft.
TENDER.	
Tank	Water bottom
Frame	Steel channels
Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	9,000 gals.
Coal capacity	15 tons

*Includes 32 sq. ft. for arch tubes.

THE DEVELOPMENT OF LOCOMOTIVE TUBES AND THEIR TREATMENT

The present status of the manufacture of locomotive boiler tubes and a review of main points requiring attention in order that the best service may be attained under modern conditions, were admirably presented in a paper by F. N. Speller of the National Tube Company, read at the April 28 meeting of the Pittsburg Railway Club. After an interesting comparison between former universally used charcoal iron tube and the now fully developed tube of basic open hearth steel, low in carbon, and with less than 0.05 per cent. phosphorus and sulphur, it was pointed out that there is no difficulty in securing a strong weld with this steel. Attention was also called to the fact that seamless and lap welded steel tubes are now made from practically the same grade of soft basic open hearth steel. Mr. Speller then presented the following main points which invite consideration in following out the process:

1. Resistance to Corrosion.

The manufacturer should furnish a tube in the best possible condition to withstand corrosion and pitting; that is, the metal should be as uniform in composition and density as it is possible to make it. Much can be done to lessen the tendency to pitting by proper attention to the making of steel and the way it is worked. We have been experimenting on this problem now for several years and have gone to considerable trouble in the matter of testing and inspection of material, and in the process used for manipulating the steel so as to produce a tube which will resist corrosion as well as iron can be made to do so, and, judging from the reports of comparative service tests which have been received, steel so made is, in this respect at least, the equal of the best charcoal iron.

After all, however, the solution of this problem is largely in the hands of the user. Iron or steel will corrode in spite of anything that can be done if certain material is in solution in the water, particularly dissolved oxygen or carbonic acid. By the removal of these harmful agencies corrosion may be reduced to practically nothing. It is generally understood nowadays that water conditions have everything to do with corrosion, and the simplest solution of the problem is to treat the water, with the object of making it as harmless as possible. The development of the modern tube to withstand corrosion and the treatment of water have together practically eliminated this trouble, so that it is rarely the case that tubes fail nowadays through pitting.

2. Leaking in the Flue Sheet.

The construction and handling of the engine has so much to do with the trouble experienced from leaky flues that it is difficult to determine how much, if any, of the responsibility for this should be placed on the tube material. If railroad engineers will tell us what qualities are required in the tube to make it hold tight in the flue sheet, we will be glad to follow their suggestions as closely as possible. At the present time the steel tube is made as stiff as possible consistent with the best welding quality and ability to stand up successfully under expansion and beading in the tube sheet.

3. Strength and Ductility of Material.

The tube should be of such quality as to stand repeated tightening in the flue sheet without cracking or showing undue evidence of fatigue, nor should these weaknesses develop during the life of the flue in service. The material found best adapted to give these properties is a special grade of soft open hearth steel carrying not over 0.05 per cent. phosphorus or sulphur.

4. Weldability and Heat Treatment.

The quality of the metal and method of handling are equally important in safe ending. Soft steel has been found somewhat harder to weld than charcoal iron, but it has been greatly improved in this respect. The necessity for a good welding quality steel is of first consideration in making locomotive tubes so that they may be easily safe ended, and this point has received a great deal of study, especially in the manufacture of lap-welded tubes, where it is, of course, one of the first essentials to manufacture. Charcoal iron carries considerably more impurities than soft open hearth steel, and these impurities form a self-fluxing mixture which facilitates welding. Railroad specifications have been so tightly drawn on composition in some cases as to work against the production of a good quality of steel for locomotive boiler tubes by calling for unnecessarily low phosphorus and sulphur. There is now very good reason to think that a mistake has been made in this direction, and that the general welding quality of the steel would be much improved, and the steel at the same time would lose nothing in other respects, if the maximum phosphorus and sulphur limits were both raised to 0.05 per cent. With producer gas, now generally used of necessity, it is a very difficult matter to keep the average sulphur in the heat below 0.035 per cent., and in order to remove this sulphur in the open hearth furnace the steel has to be held and worked in such a way as frequently to leave it dry and difficult to weld.

Before the steel can be welded in practice a fluid cinder must be formed on the surfaces which are to be united. If the metal is heated too far above the point at which this cinder should flow, it will be burned and destroyed. We endeavor to have the range of temperature between the cinder forming and burning points in the steel as wide as possible so as to assist in lap welding and give the largest margin of safety in safe ending. Considering the variety of the requirements it seems to us that the compositions of the metal should be left largely to the discretion of the manufacturer so far as is consistent with a certain specified standard of physical quality in the finished tube. We frequently go to the trouble of rephosphorizing for the purpose of improving the fluxing and welding quality of our steel.

The method of safe ending, we have said, has as much to do with obtaining satisfactory results as the material, but we will not attempt to lay down specific rules as to construction of the furnace and heating, for many of the practical shop men present who are welding flues every day are much more able to discuss this side of the problem. However, there are a few broad principles on the heat treatment of tube steel which should be taken into consideration. The preliminary heating of the body tube preparatory to flaring out the end should be carried to a bright orange color judging by good shop light, 1,750 degrees F. In the case of steel on steel, if the body tube is allowed to cool black after heating to this temperature and inserting the safe end, the grain structure will be refined and the metal put in much better condition for the welding operation which follows. Moreover, if the preheated body tube is returned to the furnace without cooling the metal may be crystallized or burned before the safe end has been heated hot

FLANGE, CRUSHING AND FLATTENING TESTS.

enough to weld. Should there be any considerable difference in thickness between the safe end and body tube, it is evident that there is again a risk of overheating the one before the other is sufficiently heated to weld. If the body tube is returned to the furnace while red hot and the safe end is at the same time a gauge or two heavier, there is, of course, all the more chance of crystallizing or burning the body tube at or near the weld. Taking unnecessary risks of this kind often explains subsequent failures which should not be charged up to the flue maker.

It is not unusual for a flue welder who has never handled steel to have trouble for a few days. Remembering the above points and using his experience to the best advantage as to the condition of his furnace, the character of the flame, temperature, etc., the average man will soon be able to do equally reliable work with steel as with charcoal iron, as the experience of welders all over the country will show.

5. UNIFORMITY OF MATERIAL.

This is a quality which the tubes should have in a high degree, both as to physical and chemical properties. There is no difficulty as to the average steel tube nowadays standing the master mechanics' tests made on one sample out of each hundred tubes. We have, however, recently designed a machine to make the flange, crushing down and flattening test on each end of every tube, as shown in the illustration. This gives assurance both as to the character of the metal in each individual tube and also, in the case of lap welded tubes, as to the welding quality being satisfactory. Steel tubes are now made in one grade of material suitable for either body tube or safe ending.

THE RAIT LOCOMOTIVE STOKER

A new form of underfeed locomotive stoker which in its operation differs from previous methods of distributing the fuel is shown in the accompanying illustrations and has been patented by George B. Rait, of Minneapolis, Minn.

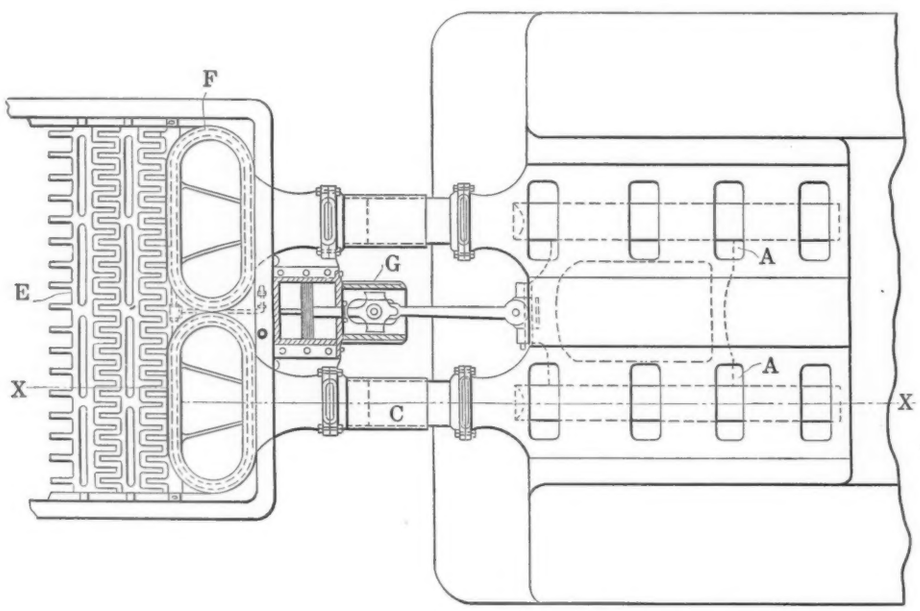
This design is prominently characterized by a high degree of simplicity, and infringes to a minimum on the space available for the movement of the engine crew. In the design of this stoker the recognized requirements for such a device have been borne prominently in mind by the inventor, i. e., compactness, detachability, in case of failure; freedom from complication, substantial construction, accessibility to repairs, and even distribution of fuel. The claim is also advanced that this invention allows of manipulation without the fireman leaving his seat, and that by very little hand labor imposed upon him while the locomotive is in motion he is better enabled to assist in the lookout, and thus reduce danger in the operation of the train.

In brief, the device consists of a charging mechanism (A) which delivers fuel from the tender (B) to a flexible conveying tube (C) lying between the engine and tender, an expanded tube or coking chamber (D) which receives the fuel from the flexible conveyor, a grate (E) on which the fuel is distributed, and the blowing mechanism (F) for distributing the fuel on the grate. An engine (G) driven by steam from the locomotive boiler operates the charging mechanism.

The charging mechanism may be readily understood through reference to the accompanying plan and sectional drawings. It will be noted that the coal falls through a series of rectangular openings into the path of the reciprocating plunger. The series of depressions and forwardly pointing teeth in the latter form a conveyor adapted to gradually advance the fuel received at any point in the hopper chamber until it drops down in front of the plunger, and is forced through the flexible conveying tubes (C).

The forward end of these tubes opens into a tubular chamber, continuous with the coking chamber (D). This chamber lies below the level of the fire grate, and slopes upward to the rear end of the grate, forming an underfeed chamber in which the fuel is gradually brought to the temperature of the fire grate, and in which the light gases of the fuel are driven off, allowing them to be consumed by the incandescent material lying above the fire grate.

The distribution of the fuel over the grate is effected by a blower (F) connected to the rim of the coking chamber (D) and immediately above the level of the grate at that point. It consists of a blowing ring, surrounding the opening of the coking chamber and having a number of openings, directed upward and forward, to which blasts of steam are supplied for the purpose of blowing the partially coked fuel forward on the grate, and to aid in the combustion of the mass of fuel in the chamber (D). This ring is supplied by exhaust steam from the engine (G) which operates the charging mechanism.

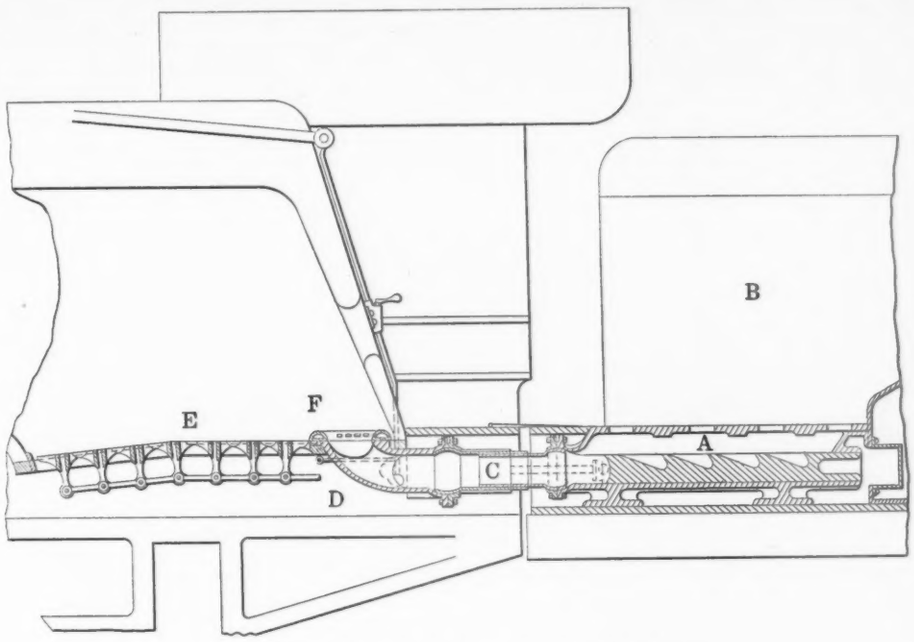


PLAN OF THE NEW RAIT LOCOMOTIVE STOKER.

This engine is quite similar to the Westinghouse or New York air pump. It has a piston working in a horizontal cylinder actuating the reciprocating plungers of the charging mechanism and a throttle valve on a live steam supply pipe operated by a hand lever near the fireman's seat, by means of which the charging mechanism can be operated at pleasure. The exhaust from the stoker engine will, of course, be considerably restricted on account of being confined in the blowing rings, but this serves an apparently very good purpose as it takes care of the exhaust, and at the same time serves as a cushion for the stoker engine.

In adopting the device to locomotives with unusually wide fireboxes the general arrangement as herein indicated is preserved on the tender, but in the firebox the coking ducts (D)

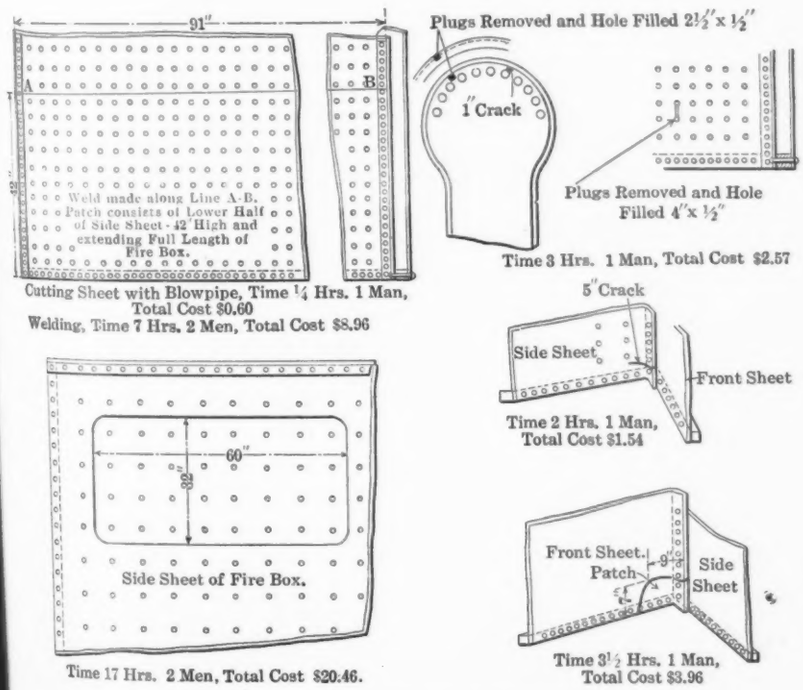
are spread further apart. It is believed that this spreading with the actual widening of the ducts themselves will allow the application of the stoker to the largest firebox which is now incorporated in locomotive design.



SECTIONAL VIEW, SHOWING CHARGING MECHANISM.

OXY-ACETYLENE WELDING ON BOILERS

As an addition to the extensive collection of illustrations and full data of work being done with the oxy-acetylene process at the Collinwood shops, which appeared on page 203 of the June issue of this journal, the Linde Air Products Co. of Buffalo furnish us with the following illustration of fire box patching, together with the time required for doing the work and its total cost. In each case the time inciudes the delays in making electric light connections, waiting for boiler makers to vacate the fire box, time consumed in preparing for welding, but does not include the time necessary to make and fit the patch. All of this work was performed by the apparatus manufactured by the Linde Air Products Company, and this data was collected from practical examples which came to its notice while investigating the results being obtained from its machines.


91"
A
B
Weld made along Line A-B.
Patch consists of Lower Half of Side Sheet 42" High and extending Full Length of Fire Box.
Cutting Sheet with Blowpipe, Time ¼ Hrs. 1 Man, Total Cost $0.60
Welding, Time 7 Hrs. 2 Men, Total Cost $8.96
Plugs Removed and Hole Filled 2½" x ½"
1" Crack
Plugs Removed and Hole Filled 4" x ½"
Time 3 Hrs. 1 Man, Total Cost $2.57
5" Crack
Side Sheet
Front Sheet
Time 2 Hrs. 1 Man, Total Cost $1.54
60"
Side Sheet of Fire Box.
Time 17 Hrs. 2 Men, Total Cost $20.46.
Front Sheet.
Patch
Side Sheet
Time 3½ Hrs. 1 Man, Total Cost $3.96

EXAMPLES OF OXY-ACETYLENE BOILER WELDING.

B. & O. R. R. TO ABANDON TRAIN DISPATCHING BY TELEPHONE. —Announcement comes from Pittsburg, following experiments of over three months in dispatching trains by telephone, that the Baltimore and Ohio Railroad Company has decided to abandon them, and announces that the telegraph will continue to be used throughout the system.

BULLETIN No. 48, "RESISTANCE TO FLOW THROUGH LOCOMOTIVE WATER COLUMNS," by Arthur N. Talbot and Melvin L. Enger, records the results of tests of fourteen of the principal forms of locomotive water columns or cranes in use on the railways of the United States. Besides giving the loss of head at various rates of discharge, the tests povide data on the hydraulic characteristics of the valves. Water hammer, relief valves, friction losses through pipe lines, and methods to be used in the design of water service installations are also considered. The bulletin should be of interest to motive power and maintenance of way men. Copies of this bulletin may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experimental Station, University of Illinois, Urbana, Illinois.

TICLIO, THE HIGHEST RAILWAY STATION IN THE WORLD, on the Central Railway of Peru, is 15,665 ft. above the sea. On the left the main line descends sharply to Callao, and on the right the Morococha branch winds over the range, which it crosses at the elevation of 15,865 ft., the highest point reached by any railway in the world.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO TOTAL WEIGHTS

MALLET ARTICULATED COMPOUND LOCOMOTIVES

TYPE	2-10-10-2	2-8-8-2†	0-8-8-0	0-8-8-0	2-8-8-2	2-8-8-2	2-8-8-2	2-8-8-2	0-8-8-0	2-6-6-2	2-8-8-2	2-6-8-0	4-4-6-2†	0-8-8-0	2-6-6-2	2-6-6-2	0-6-6-0	0-6-6-0
NAME OF ROAD	A. T. & S. F.	A. T. & S. F.	B. & O.	D. & H.	V. R. R.	N. P.	S. P.	S. L. & S. F.	Erie	C. & O.	N. & W.	G. N.	A. T. & S. F.	N. & W.	C. B. & Q.	B. & A.	D. N. W. & P.	Can. Pac.
Road number or class	3,000	1,700	2,401	1,600	600	4,000	4,000	2,001	2,600	H. 1	Y-I	1,959	1,300	X-1	4,100	1,249	200	1900
Builder	R. R. Co.	Bald.	Bald.	Amer.	Bald.	Bald.	Bald.	Amer.	Amer.	Amer.	Bald.	Bald.	Bald.	Amer.	Bald.	Amer.	Amer.	Can. Pac.
When built	1911	1909	1911	1910	1910	1910	1909	1910	1907	1910	1910	1909	1909	1910	1909	1910	1909	1909
Tractive effort, lbs.	111,600	108,300	105,000	105,000	100,800	94,640	94,640	83,300	94,800	82,000	77,000	82,000	62,850	85,000	70,500	66,600	74,130	57,400
Weight, total, lbs.	616,000	462,450	461,000	445,000	448 750	437,950	425,900	425,000	410 000	392,000	390,000	378.300	376,850	376,800	361.650	342.000	327,500	262.000
Weight on drivers, lbs.	550.000	412,350	461,000	445,000	405,400	403,800	394,150	365,000	410,000	324,000	360,000	359.600	268,400	376,800	304,500	296,500	327,500	262,000
Weight on leading truck, lbs.	.....	24,050	.....	.....	21,000	18,750	14,500	25 500	.....	22,000	15 000	18,700	58,050	.....	21.000	.....	.....	.....
Weight on trailer, lbs.	.....	26,050	.....	.....	22,350	15,400	17,250	34,500	.....	46,000	15,000	.....	50,400	.....	36,150	.....	.....	.....
Weight, tender loaded, lbs.	234,000	234,000	181,500	166,800	171,130	152,000	170,100	162,420	167,700	164,300	170,000	147,700	234,000	161,860	153,400	152,700	159,800	139,000
Wheel base, driving, front group	19′ 9″	16′ 6″	15′	14′ 9″	15′	16′ 0″	15′ 0″	15′ 6″	14′ 3″	10′	15′ 6″	10′	6′ 4″	15′ 6′	11′ 6″	10′	10′	10′ 4″
Wheel base, driving, rear group	19′ 9″	16′ 6″	15′	14′ 9″	15′	16′ 0″	15′ 0″	15′ 6″	14′ 3″	10′	15′ 6″	15′	12′ 8″	15′ 6′	11′ 6″	10′	10′	10′ 4″
Wheel base, total engine	66′ 5″	59′ 10″	40′ 8″	40′ 2″	58′ 2″	56′ 7″	56′ 7″	56′ 8″	39′ 2″	48′ 10″	55′ 6″	43′ 11″	51′ 11″	41′ 2″	51′ 5″	30′ 8¾″	30′ 8″	35′ 2″
Wheel base, engine and tender	108′ 1⅛″	98′ 0⅜″	77′ 2⅜″	75′ 7½″	89′ 2⅛″	82′ 7¾″	83′ 6″	85′ 6½″	70′ 5¼″	80′ 3½″	83′ 3″	76′ 2½″	94′ 5½″	72′ 10″	83′ 2½″	74′ 8″	64′ 4″	60′ 7′
Diameter of drivers	57″	63″	56″	51′	56″	57″	57″	57″	51″	56″	56″	55″	73″	56″	64″	57″	55″	58″
Cylinders, high pressure, diameter	28″	26″	26″	26″	26″	26″	26″	24″½	25″	22″	24½″	23″	24″	24½″	23″	20½″	20½″	23½″
Cylinders, low pressure, diameter	38″	38″	41″	41″	40″	40″	40″	39″	39″	35″	39″	35″	38″	39″	35″	33″	33″	34″
Cylinders, stroke	32″	34″	32″	28″	32″	30″	30″	30″	28″	32″	30″	32″	28″	30″	32″	32″	32″	26″
Steam pressure, lbs.	225	220	210	220	210	200	200	200	215	225	200	200	220	200	200	210	225	200
Boiler, type	E. W. T.	Str.	Conical	Conical	Str.	Str.	Str.	Conical	Str.	Conical	Str.	Belp.	Str.	Str.	Str.	Str.	Str.	W. T.
Boiler, smallest diameter	79″	84″	90″	90″	86″	84″	84″	81⅝″	84″	83⅞″	80″	84″	72″	83⅞″	78″	83¾″	84″	57¾″
Boiler, height center	.....	.....	10′ 1″	10′	10′ 3″	.....	120″	10′	10′	10′	.....	.....	118″	10′	114½″	119½″	120″	110¾″
Heating surface, tubes, sq. ft.	3,625	4,766	5,205.5	6,276	4,934	4,941	4,941	4,817	4.971	5,646	4,309	3,038	3,275	5,188	2,708	5,291	5,035	2,605
Heating surface, firebox, sq. ft.	294.5	243	321.4	353	250	252	232	350	343	344	210	225	202	200	210	185	206	180
Heating surface, feed heater, sq. ft.	2,659.5	1.665	.....	.....	.....	1,220	.....	.....	.....	.....	1 389	1,797	1,279	.....	2,172	.....	.....	.....
Heating surface, superheater, sq. ft.	2,328.4	544	1 002	.....	.....	.....	655	.....	.....	.....	.....	480	323	.....	464	.....	.....	420
Heating surface, reheater, sq. ft.	.....	1,201	.....	.....	1,694	655	.....	.....	.....	.....	586	.....	798	.....	.....	.....	.....	.....
Heating surface, total,* sq. ft.	6,579	6,674	5,526.9	6,629	5,184	6,413	5,173	5,167	5,314	6,013	5,908	5,060	4,756	5,388	5,090	5 476	5,241	2,785
Grate area, sq. ft.	81.9	70.8	99.9	100	84	84	68.4	75.4	100	72.2	75.2	78	52.5	75	63	56.5	72.2	58
Firebox, length	149⅝″	129⅝″	123⅛″	126½″	126′ 1⅛″	126″	126″	120⅛″	126¼″	108¼″	120⅛″	117″	119⅝″	120¼″	120″	108″	108″	120″
Firebox, width	78¾″	78⅝″	114″	114″	96″	96″	78¼″	90¾″	114¼″	96½″	19¼″	96″	63½″	90¾″	78¼″	75¼″	96″	69⅜″
Fuel, kind	Oil	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil.	Bit. coal	Lignite	Bit. coal	Bit. coal	Bit. coal
Tubes, number	377	387	277	446	401	401	401	342	404	401	350	275	294	367	218	410	409	**
Tubes, diameter	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	**
Tubes, length	16′ 5″	21′	24′	24′	21′	21′	21′	24′	21′	24″	21′	15′	19′	24′	16′ 6″	22′	21′	**
Tender, fuel capacity, tons	4,000	4000	16	14	15	13	2,850	16	16	15	14	13	4.000	14	13	12	12	12
Tender, water capacity, gallons	12,000	12,000	9,500	9,000	9,500	8,000	9,000	8,000	8,500	9,000	9,000	8,000	12.000	9,000	8,000	8,000	9,000	6,000
Weight on drivers ÷ tractive effort	4.93	3.78	4.42	4.23	4.16	4.26	4.18	4.32	4.32	3.96	4.67	4 38	4.27	4.42	4.33	4.45	4.40	4.57
Weight, total ÷ tractive effort	5.52	4.24	4.42	4.23	4.60	4.63	4.51	5.01	4.32	4.78	5.06	4.60	5.99	4.42	5.13	5.13	4.40	4.50
T. E. × diam. drivers ÷ total H. S.	967.00	1022.00	837.00	807.00	785.00	840.00	1040.00	919.65	910.00	763.00	730.00	894.00	965.00	887.00	886.00	693.00	780.00	1190.00
Total heating surface ÷ grate area	80.33	94.50	55.00	66.29	82.50	76.60	75.60	68.45	53.14	83.40	78.50	65.00	90.50	71.00	80.80	97.00	72.60	48.00
Firebox H. S. ÷ total H. S., %	4.47	3.65	5.80	5.31	4.82	3 90	4.50	6.11	6.46	6.10	3.55	4.45	4.25	3.95	4.13	3.40	3	6.46
Weight on drivers ÷ total heating surface	83.60	62.00	83.20	67.00	58.40	62.50	76.00	69.43	76.90	54.00	61.00	71.00	56.30	69.70	59.80	54.00	62.20	94.00
Weight, total ÷ total heating surface	93.63	69.40	83.20	67.00	64.70	68.00	82.50	80.97	76.90	65.30	66.00	75.00	79.20	69.70	71.00	62.00	62.20	94.00
Total H. S. ÷ superheating H. S.	2.39	12,40	5.25	.....	.....	.....	7.90	.....	.....	.....	.....	10.50	14.70	.....	10.97	.....	.....	6.63
Equivalent simple cylinder volume, cu. ft.	30.20	33.10	29.70	26.00	29.30	28.84	28.84	25.50	24.00	21.80	23.05	24.10	20.60	25.50	24.10	19.32	19 4	16.90
Total H. S. ÷ cylinder volume	217.85	205.00	237.00	254.00	236.00	223.00	180.00	202.42	222.00	276.00	256.00	210.00	232.00	210.00	212.00	283.00	270.00	165.00
Superheating H. S. ÷ cylinder volume	.....	16.40	.....	.....	.....	.....	22.70	.....	.....	.....	.....	19.90	15.74	.....	19.30	.....	.....	24.80
Grate area ÷ cylinder volume	2.71	2.14	3.36	3.85	2.87	2.91	2.38	2.95	4.70	3.31	3.26	3 24	2.54	2.96	2.64	2.92	3.70	3.44
Reference in THE AMERICAN ENGINEER, year, month and page	1911 May 171	1909 Dec. 477	1911 May 182	1910 June 207	1910 Nov. 427	1910 June 225	1909 May 181	1911 Feb. 50	1907 Sept. 338	1910 Dec. 471	1910 July 269	1910 Aug. 308	1909 Dec. 475	1910 Sept, 341	1910 May 171	1910 April 135	1909 Fe . 61	1910 March 81

* Includes boiler heating surface and feed water heating surface.
† Equipped with Jacobs superheater and feed heater.

** For number and size of tubes see AMERICAN ENGINEER, p. 80, March, 1910.

* Includes boiler heating surface and feed water heating surface.
† Equipped with Jacobs superheater and feed heater.

** For number and size of tubes see AMERICAN ENGINEER, p. 89, March, 1910.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED IN ORDER OF TOTAL WEIGHTS

FREIGHT AND SWITCHING LOCOMOTIVES

TYPE	CONSOLIDATION (2-8-0)									12-Wh'l 4-8 0	MIKADO 2 8-2					SWITCHING 0-10-0	SWITCHING 0-8 0	SWITCHING 0-6 0
NAME OF ROAD	N. Y. S. & W.	D. & H.	P. R. R.	W. P. T.	H. V.	L. S. & M. S.	C. & N. W.	C. G. W.	A. T. & S. F.	N. & W.	B. & O.	O. R. & N.	N. P.	C. M. & St. P.	V. R. R.	L. S. & M. S.	V. R. R.	P. & L. E.
Road number or class	140	1,011	H. 8 B.	918	C 10	5,962	1,455	503	1,950	M. 2	Q. 1	440	1,608	5,202	421	M.	2	253
Builder	Bald.	Amer.	P. R. R.	Amer.	Amer.	Amer.	Amer.	Bald.	Bald.	Bald.	Bald.	Bald.	Amer.	R. R. Co.	Baldwin	Amer.	Amer.	Amer.
When built	190-	1906	1909	1909	1910	1906	1910	1909	1908	1910	1911	1910	1906	1909	1909	1905	1909	1906
Simple or compound	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple
Tractive effort, lbs.	54,100	49,690	42,661	46 900	48,500	45,677	47,500	46,630	44,000	52,457	50,200	45.300	46,630	46,630	50,350	55,300	45,200	44,100
Weight, total, lbs.	260,100	246.500	238,300	236,000	236,000	232,500	232.000	222,650	212,400	262,000	274,600	263,100	261,000	260,500	254,000	270,000	182,300	178 200
Weight on drivers, lbs.	232,700	217,500	211,000	207,000	208,000	207,000	205,000	198,850	183,200	221,780	219.000	204,450	205,000	201,000	207,450	270,000	182 300	178,200
Weight on leading truck, lbs.	27,400	29,000	27,300	29,000	28,000	25,500	....	23,800	29,200	40 220	19,500	24,100	26,000	25,500	20.850	.....	.....	.....
Weight on trailer, lbs.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	36,100	34,550	30,00	34,500	25,700	.....	.....	.....
Weight, tender loaded, lbs.	161,900	152,400	158,000	154.000	154.000	149.600	150,900	144.000	175,200	146,700	1*1,500	161,900	177,800	154,000	173,000	.....	111,400	121,300
Wheel base, driving	17′ 0″	17′ 0″	17′ 0½″ 25′ 9½″	15′ 9″	17′ 3″	17′ 6″	17′ 6″	17′	15′ 6″	16′	16′ 9″	16′	16′ 6″	16′ 6″	15′ 6″	19′ 0″	14′	12′ 0″
Wheel base, engine	26′ 6″	25′ 11″	59′ 5⅝″	25′	26′ 5′	26′ 5″	26′ 5″	25′ 8″	24′ 6″	27′ 1″	35′	34′ 8″	34′ 9″	35′ 1″	33′	19′ 0″	14′	12′ 0″
Wheel base, engine and tender	60′10″	57′ 7½″		59′ 11″	58′ 3″	60′ 9½″	60′ 9½″	58′ 6″	58′ 5″	61′ 1½″	71′ 1⅜″	64′ 7″	63′ 1″	65′ 7⅛″	65′ 10¼″	54′ 5½″	49′ 6¼″	46′ 2¼″
Diameter of drivers	63″	57″	62″	58″	57″	63″	61″	63″	57″	56″	64″	57″	63″	63″	56″	52″	51″	50″
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter and stroke	28″ × 32″	23″ × 30″	24″ × 28″	25″×32″	23″ × 30″	23″ × 32″	25′ × 32″	24″ × 30″	24″ × 32″	24″ × 30″	24″ × 32″	23¾″×30″	24″ × 30″	24″ × 30″	24″ × 32″	24″ × 28″	22″ × 28″	21″ × 30″
Valve gear, type	Wals	Wals.	Wals.	Wals.	Baker	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Steph.	Steph.
Steam pressure, lbs.	160	210	205	160	205	200	170	200	160	200	205	180	200	200	180	210	200	200
Boiler, type	Str.	Wooten	Belp.	E. W. T.	E. W. T.	Str.	Str.	Str.	Str.	W. T.	E. W. T.	Str.	E. W. T.	E. W. T.	Str.	W. T.	Str.	Str.
Boiler, smallest diameter	84″	83⅜″	76⅜″	80″	80″	81⅝″	81½″	80″	78¾″	80″	78″	82″	75¾″	75¾″	78¾″	80⅛″	74″	80″
Boiler, height center	120″	113″	117″	....	9′ 9″	118¼″	120½″	.....	114″	9′ 11¼″	9′ 8″	9′ 7⅛″	118″	118″	112″	115″	109″	108½″
Heating surface, tubes, sq. ft.	3,931	3,716	3,652	3,093	3,328	3492.18	3 499	3.514	2,773	4,281	4,789	5,292	3,192	3,332	4,277	4,422.6	2,763	2,906
Heating surface, firebox, sq. ft.	198	329.5	187	190	202	213.05	214	171	157	179	228	267	245†	282†	189	197	177	206
Heating surface, total, sq. ft.	4,129	4045.5	3,839	3,283	3,503	3705.23	3,713	3,685	2,930	4,460	5.017	5,559	3,437	3,614	4,466	4,619.6	2,940	3,112
Heating surface, superheater, sq. ft.	834	.....	.....	374	.....	.....	.....	.....	600	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grate area, sq. ft.	60.2	99.85	55.13	50.5	55	56.5	52.7	49.5	47.4	45	70	70	43.5	48.8	51	55.4	31.5	33.3
Firebox, length	120″	126⅛″	110¼″	109″	108¼″	108⅛″	108⅛″	108″	95⅝″	100⅛″	120″	120″	96″	107″	102″	108¼″	108″	120″
Firebox, width	72¼″	114″	72″	68″	73¼″	75¼″	70¾″	66″	71¼″	64¼″	84″	84″	65¼″	65¾″	72″	73¼″	42″	40
Fuel, kind	Bit. coal	Anth. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Lignite	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tubes, number firetube	472	493	465	358	412	446	443	413	355	386	389	495	372	366	374	447	564	430
Tubes, number superheater	.....	.....	.....	20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tubes, diameter, firetube	2″	2″	2″	2″	2″	2″	2″	2″	2″	2¼″	2¼″	2″	2″	2″	2¼″	2″	2″	2″
Tubes, diameter, superheater	.....	.....	.....	5½″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tubes, length	16′	14′ 6″	15′	14′ 6″	15′ 6″	15′	15′ 2″	16′ 4″	14′ 11″	18′ 10″	21′	20′ 6″	16′ 6″	17′ 6″	19′ 6″	19′ 0″	15′	13′ 0″
Tender, coal capacity, tons	15	14	17.50	14	16	12	12	12.50	3.300 G	14	16	10	12	14	16	12	10	10
Tender, water capacity, gals.	9,000	7,800	7,000	8,000	7,500	7,500	7,500	8,000	8,500	9.000	9,500	9.000	10,000	8,000	9,500	8 000	5,000	7,000
Weight on drivers ÷ tractive effort	4.30	4.30	4.95	4.41	4.29	4.50	4.30	4.28	4.17	4.08	4.37	4.50	4.38	4 31	4.10	4 86	4.03	4.04
Weight, total ÷ tractive effort	4 80	4.97	5.59	5.03	4.87	5 00	4.8º	4.77	4.75	4.99	5.47	5 80	5 60	5.80	5.05	4.86	4.03	4 04
T. E. × diam. drivers ÷ total H. S.	825.00	700.00	€89.00	825.00	783.14	775.00	780.00	796.00	855.00	714.00	641.00	465.00	855.00	812.80	631.00	625.00	785.00	710.00
Total heat. surf. ÷ superheater heat. surf.	68.50	40.50	69.64	65.00	64.18	65.80	70.40	74.30	62.00	91.80	71.80	79.30	78.80	74.00	87.50	83.00	93.20	94.00
Firebox heat. surf. ÷ total H. S., %	4.80	8.12	4.87	5.80	5.72	5 75	5.00	4.65	5.35	4.43	4.56	4.80	7.12	7.80	4.23	4.25	6.04	6.60
Weight on drivers ÷ total heating surface	56.00	53.50	54.96	63.00	58.92	55 80	53.90	54.00	62 50	51.80	43.80	36.70	59.60	55.62	46.50	58.30	62.00	57.10
Weight, total ÷ total heating surface	53.00	60.80	62.07	71.70	66.86	6.25	62.30	60.40	72.50	63.50	54 80	47.30	75.50	72.21	56.90	58 30	62.00	57.10
Total heat. surf. ÷ superheating heat. surf.	5.00	.....	.....	8.78	.....	.....	.....	.....	4.90	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cylinder volume, cu. ft.	22.70	14.40	14.66	18.20	14.42	15.40	18.16	15.60	16.80	15.80	16.80	16.00	15.80	15.70	16.75	14.70	12.35	12,00
Total heating surface ÷ cylinder volume	181.00	280.00	261.89	181.00	244.80	242.00	204.00	236.20	174.50	260.00	300.00	360.00	218.00	230.19	266.00	314.00	239.00	260.00
Superheater heat. surf. ÷ cyl. volume	36.80	.....	.....	20.60	.....	.....	.....	.....	35.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grate area ÷ cylinder volume	2.65	6.92	3.76	2.78	3.81	3.66	2.90	3.18	2.82	2 83	4.17	4.53	2,76	3 10	3.05	3.78	2 55	2 77
Reference in THE AMERICAN ENGINEER, year, month, page	1907 Aug. 300	1907 Jan. 22	1910 Feb. 69	1909 June 256	1910 Dec. 478	1906 July 262	1910 July 259	1910 Feb. 64	1908 Mar. 112	1911 Jan. 6	1911 Aprl. 143	1910 Oct. 404	1906 Oct. 392	1909 Aug. 305	1909 June 225	1905 Sept. 330	1909 Sept. 357	1906 Sept. 346

† Includes combustion chamber.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

PASSENGER LOCOMOTIVES OF THE PACIFIC (4-6-2) AND PRAIRIE (2-6-2) TYPES

TYPE.	PACIFIC (4-6-2)														PRAIRIE (2-6-2)			
Name of road	P. R. R.	N. Y. C.	B. & O.	Vandalia	C. & N.W.	C. M. & St. P.	C. & A.	C. N. & W.	C. & A.	G. N.	C. B. & Q.	A. T. & S. F.	N. Y. N. H. & H.	C. B. & Q.	A. T. & S. F.	C. B. & Q.	N. P.	G. N.
Road number or class	K 28	3426	2140	V K 1	E	F 4	623	1,500	605	1,445	2,850	1290	I1	S1	1800	R5	2,378	J1
Builder	Amer.	Amer.	Bald.	Amer.	Amer.	C. M. & St. P.	Amer.	Amer.	Bald.	Bald.	Bald.	Bald.	Both		Bald.	Amer.	Amer.	Bald.
When built	1907	1911	1911	1910	1910	1910	1909	1910	1908	1909	1909	1908	1907	1906	1906	1906	1906	1906
Simple or compound	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Comp.	Simple	Simple	Simple
Tractive effort, lbs	30,700	30,900	43,400	31,800	33,700	36,500	31.475	31,900	34 000	35,300	31,100	32,600	31,560	31,100	37,800	35.060	33,300	37.560
Weight, total, lbs	272,500	269,000	263,800	256,000	250,000	248,800	248,000	245,000	243.200	235,750	234,900	232,750	229,500	228,000	248,200	216,000	209,500	209.000
Weight on drivers, lbs	183 900	171,500	166,200	162,000	154,500	160,100	149,500	151,000	146,500	152,000	160,150	140,400	142,500	150,000	174.700	152,000	152,000	151,000
Weight on leading truck, lbs	.....	50,000	52,400	49,500	51,000	46,000	.....	.....	47,600	39,900	37,400	54,950	46,500	42,000	31,300	25,600	.....	21,000
Weight on trailer, lbs	.....	47,500	45,200	44,000	45,000	42.700	.....	.....	49,100	43.850	37,350	37.400	41,000	36,000	42,200	38,400	.....	37 000
Weight, tender loaded, lbs	143,800	153,200	176.200	145,950	166,200	154,590	165,120	154,000	161,800	146.200	155,100	165,200	134,000	148,200	175,000	148,200	139,500	151,000
Wheel base, driving	13′ 10″	14′	13′	13′ 10″	13′ 6″	14′	13′ 9″	13′ 6″	13′ 9″	13′	12′ 10″	1-′ 8″	13′ 1″	12′ 10″	13′ 8″	13′ 4½″	11′ 0″	13′ 0″
Wheel base, engine	35′ 2½″	36′ 6″	34′ 8″	34′ 8½	34′ 7″	35′ 7″	34 8½″	34′ 7″	32′ 8″	33′ 9″	32′ 9 ′	34′ 4½″	33′ 5½″	32′ 9″	33′ 9″	30′ 8½″	28′ 11″	30′ 9″
Wheel base, engine and tender	67′ 3¾″	67′ 11″	70′ 10⅜″	66′ 6″	66′ 10½″	67′ 1⅜″	66′ 4″	66′ 10½″	65 8½″	66′ 7½″	64″ 3½″	65′ 2″	61′ 2″	64′ 3¼″	65′ 0″	62′ 2¾″	57′ 3½″	63′ 8″
Diameter of drivers	80″	79″	74″	80″	75″	69″	80″	75″	73″	73″	74″	73″	73″	74″	69″	69″	63″	69″
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2
Cylinders, diameter	24″	23½″	24″	24″	25″	23″	23″	23″	23″	26″	22″	25″	22″	22″	17½″ & 29″	22″	21″	22″
Cylinders, stroke	26″	26	32″	26″	28″	28″	28″	28″	28″	30″	28″	28″	28″	28″	28″	28″	28″	30″
Valve gear, type	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Pill id	Wals.	Wals.	Wals.	Wal-.	.....	.....	Steph.	Wals.	Steph.	Steph.	Wals.
Steam pressure, lbs	205	200	205	200	170	200	200	190	200	150	200	160	200	200	225	210	200	210
Boiler, type	Str.	Conical	E. W. T.	Str.	E. W. T.	E. W. T.	E. W. T.	E. W. T.	W. T.	Belp.	W. T.	Str.	Str.	W. T.	E. W. T.	W. T.	E. W. T.	Belp.
Boiler, smallest diameter	78″	72″	78″	76½″	70 5/16″	72″	72″	70 5/16″	72″	72″	70″	72″	70″	70″	76″	70″	72⅝″	72″
Boiler, height center	119″	9′ 9″	9′ 11″	9′ 9″	9′ 8″	9′ 4″	.....	116″	113″	111″	109⅞″	114¼″	110″	109¾″	115″	107⅜″	115″	108″
Heating surface, tubes, sq. ft	4243	3,192.9	4,789	4,193.6	30.92	3,651	3,869.	4.130.	3,721.	2,920.	3,610	3,202	3,743.	3,732.	3,803.	3,375.	2,105.	3,277.
Heating surface, firebox, sq. ft	205	231.2	228	197.4	209	259	202.	236.	206.	213.	194	190	204.4	200.	217.	200.	235.	210.
Heating surface, total, sq. ft	4,448	3,424 1	5,017	4,391	3,328	3,910	4,071.	4,366.	3,927.	3,133.	3,804	3,392	3,947.4	3,932.	4,020.	3,575.	2,340.	3,487.
Heating surface, superheater, sq. ft	.....	765	.....	.....	691	.....	.....	.....	.....	620.	.....	.....	.....	.....	.....	.....	.....	.....
Grate area, sq. ft	61.86	56.5	70	56½	53	48	49.5	53	33	54.15	55	49 05	53.5	54	53.8	54.	43.5	53.15
Firebox, length	111″	108⅛″	120″	108⅛″	108½″	107 1/16″	108″	108⅛″	120⅛″	126½″	108½″	107⅞″	108½″	108½″	107 1/16″	108½″	96″	116″
Firebox, width	80½″	75½″	84″	75½″	70½″	65⅝″	66″	70¼″	40½″	66¼″	72½″	66″	71¼″	72½″	71¼″	72½″	65¼″	66″
Fuel, kind	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tubes, number firetube	343	175	389	383	214	369	373	396	357	160	293	273	310	303	342	303	306	301
Tubes, number superheater	.....	32	.....	.....	30	.....	.....	.....	.....	32	.....	.....	.....	.....	.....	.....	.....	.....
Tubes, diameter, firetube	2¼″	2¼″	2¼″	2″	2″	2″	2″	2″	2″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2″	2¼″
Tubes, diameter, superheater	.....	5½″	.....	.....	5½″	.....	.....	.....	.....	5½″	.....	.....	.....	.....	.....	.....	.....	.....
Tubes, length	21′	21′ 6″	21′	20′ 11″	20′	19′	20′	20′	20′	21′	21′	20′	20′ 6″	21′ 0″	18′ 10 5/16″	19′ 0″	13′ 3″	18′ 6″
Tender, coal capacity, tons	11	12	16	12	15	10½	14	13	12½	13	13	33,009	14	13	14	13	12	13
Tender, water capacity, gals	7,000	7,500	9,500	7,500	8,275	8,500	8,500	7,500	8,250	8,000	8,200	8.500	6,000	8,000	9,000	8,000	7,000	8,000
Weight on drivers ÷ tractive effort	6.00	5.55	3.83	5 10	4.09	4.39	4.74	4.73	4.26	4.31	5.17	4 33	4.50	4.80	4.60	4.30	4.60	4.00
Weight, total ÷ tractive effort	8.85	8.71	6.08	8.05	6.64	6.82	7 90	7.68	7.05	6.68	7.55	7.12	7.25	7.30	6.60	6.20	6.30	5.60
T. E. × diam. drivers ÷ total H. S.	550.00	534.00	641.00	580.00	846.90	641.56	618.00	548.00	640.00	822.00	605.00	700 00	585.00	585.00	650.00	677.00	900.00	746.00
Total heating surface ÷ grate area	72.00	81.00	71.80	77.50	63.15	80.12	82.30	82.40	119.00	57.65	69 20	68.50	73.50	71.30	74.00	64.80	53.80	65.00
Firebox heat. surf. ÷ total H. S., %	4.62	5.07	4 56	4.43	6.28	4.58	4 98	4.79	5.24	6.80	5.10	5 60	5.20	4.85	5.40	5.34	10.10	6.00
Weight on drivers ÷ total heat. surf.	41.50	37.50	33.10	37.00	46.12	40.95	36.60	34.80	37.30	48.51	42.40	41 50	36.20	38.00	43.50	42.50	65.00	43.50
Weight total ÷ total heating surface	61.20	59.00	52.60	58.50	75 27	63.42	61.00	56.20	62.00	75.24	61.30	68.50	58.20	58.00	62 00	60.70	89.50	60.00
Total H. S. ÷ superheater heat. surf.	.....	4.47	.....	.....	4.81	.....	.....	.....	.....	5.05	.....	.....	.....	.....	.....	.....	.....	.....
Cylinder volume, cu. ft	13.60	13.10	16 80	13.60	15.90	13.46	13 50	13.28	13.00	18.50	12.30	16.00	12.30	12.30	12.1*	12.30	11.20	13.20
Total heating surface ÷ cyl. volume	326.00	348.00	300.00	322 00	209.30	290.49	302.00	328.00	290.00	169.34	310.00	212.00	321.00	38.00	334.00	290.00	209.00	265.00
Superheater heat. surf. ÷ cyl. vol.	.....	58.38	.....	.....	43.45	.....	.....	.....	.....	3.40	.....	.....	.....	.....	.....	.....	.....	.....
Grate area ÷ cylinder volume	4.55	4.32	4.17	4.15	3 30	3.62	3.67	3.99	2.44	2.92	4.48	3.10	4.20	4.39	4.43	4.46	3.89	4.03
Reference in THE AMERICAN ENGINEER, year, month, page	1907 July 267	1911 Apr. 133	1911 Apr. 143	1910 Oct. 391	1911 Feb 56	1910 Nov. 449	1909 July 268	1910 July 259	1908 Oct. 399	1909 Oct. 413	1909 Sept. 376	1908 Mar. 112	1907 Nov. 429	1906 Aug. 300	1906 Nov. 434	1906 Aug. 300	1906 Oct. 392	1906 Sept. 364

* Equivalent simple cylinders.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

* Equivalent simple cylinders.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

PASSENGER LOCOMOTIVES OF TYPES OTHER THAN THE PACIFIC AND PRAIRIE

TYPE	ATLANTIC (4-4-2)								TEN WHEEL (4-6-0)							AMERICAN (4-4-0)		TANK (4-6-4)
Name of road	A. T. & S. F.	P. R. R.	U. P.	C. M. & St. P.	N. Y. N. H. & H.	N. P.	Har. Lines	C. R. I. & P.	B. & A.	S. P.	D. L. & W.	G. G. W.	N. Y. C.	N. C. & St. L.	C. & NW	C. R. R. of N. J.	D. L. &W.	C P.
Road number or class	1.480	E 6	21	951	F1	603	A-81	1,019	1,916	2,317	1,012	500	2,099	284	1393	852	955	T. 2 a
Builder	Bald.	P. R. R.	Bald.	Bald.	Amer.	Bald.	Bald.	Amer.	Amer.	Bald.	Amer.	Bald.	Amer.	Bald.	Amer.	Amer.	Amer.	C. P.
When built	1910	1910	1906	1907	1907	1909	1905	1905	1908	1907	1905	1909	1905	1908	1907	1905	1905	1910
Simple or compound	Comp.	Simple	Comp.	Comp.	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple.	Simple	Bal.comp	Simple	Simple	Simple	Simple
Tractive effort, lbs	23,600	25,797	24,281	22,000	24,670	24,760	23,560	24,700	31,000	36,570	35,100	33,060	31,000	29,200	30,900	23,120	23,710	28,000
Weight, total, lbs	231,675	231,500	209,000	204,119	200,000	197,050	196,000	191,300	208,000	203,300	201,000	198,050	194,500	181,400	179,500	161,300	151,200	236 000
Weight on drivers, lbs	112,125	133,300	110,000	105,966	105,500	100,800	105,000	107,100	158,000	160,000	154,000	144,950	148,000	134,000	135,500	111,300	100,000	135,000
Weight on leading truck, lbs	62,225	51,300	53,000	52 353	48,000	51,950	45,000	42,400			47,000	53,100	46,500	47,400	44,000	50,000	51.200	49,340
Weight on trailer, lbs	57,325	46,900	46,000	45 800	46,500	44,300	46,000	40,800	155,800	43,300								51,660
Weight, tender loaded, lbs	185,325	158,000	162,200	130 000	134,000	122,950	162,200	144,000		141,366	120,000	144,000	143,500	118,000	139,500	122,200	110,000	
Wheel base, driving	6′ 10″	7′ 5″	7′ 0″	7′ 6″	7′ 3″	6′ 10″	7′ 0″	7′ 0″	15′ 10″	13′ 10″	14′ 4″	15′ 3″	15′ 10″	12′ 0″	14′ 10″	8′ 3″	8′ 6″	14′ 10″
Wheel base, engine	32′ 8″	29′ 7½″	27′ 10″	32′ 2″	28′ 2″	27′ 10″	27′ 7″	27′ 5½″	26′ 10½″	25′ 10″	25′ 6″	27′ 1″	26′ 10½″	26′ 0″	25′ 10″	23′ 1½″	24′ 5″	38′ 10″
Wheel base, engine and tender	64′ 6⅝″	60′ 2⅜″	58′ 5″	66′ 9″	56′ 1″	57′ 3″	58′ 2″	57′ 2″	59′ 3″	58′ ¼″	54′ ¼″	57′ 9¼″	59′ 2″	55′ 2″	57′ 9″	49′ 2″	51′ 5⅛″	
Diameter or drivers	73″	80″	81″	85″	79″	73″	81″	73″	69″	63″	69″	73″	69″	66″	63″	69″	69″	63″
Cylinders, number	4	2	4	4	2	2	2	2	2	2	2	2	2	4	2	2	2	2″
Cylinders, diameter	15″ & 25″	22″	16″ & 27″	15″ & 25″	21″	21″	20″	21″	22″	22″	21½″	26″	22″	16″ & 27″	21″	19″	20″	20″
Cylinders, stroke	26″	26″	28″	28″	26″	26″	28″	26″	26″	28″	26″	28″	26″	26″	26″	26″	26″	26″
Valve gear, type	Wals.	Walš.	Wals.	Steph.	Wals.	Wals.	Steph.	Steph.			Steph.	Wals.	Steph.	Wals.	Wals.	Steph.	Steph.	Wals.
Steam pressure, lbs	220	205	200	220	200	185	200	185	200	200	215	150	200	210	200	200	185	200
Boiler, type	W. T.	Belp.	Str.	W. T.	E. W. T.	Str.	Str.	Str.	E. W. T.	W. T.	Str.	Str.	W. T.	W. T.	E. W. T.	W. T.	Str.	W. T.
Boiler, smallest diameter	72″	78½″	70″	66″	68″	72⅛″	70″	72″	72½″	72″	74⅜″	70″	70⅝″	64″	66⅜	62¼″	61 3/16″	62½″
Boiler, height center	9′ 8⅞″	9′ 10″	113″	114″	110″		113″	108″	115	102″	116½″		115″	107″		113″		8′ 9⅜″
Heating surface, tubes, sq. ft	2 318	3 364	2475.	3008.	3041.	2112.	2475.	2227.6	3104.5	2788.	3156.3	2,206	3124.7	2550	2808.4	1838.1	1947.9	1,644
Heating surface, firebox, sq. ft	208	218	180.	168.	204.4	173.	174.	161.8	203.3	206.	221.7	149	202.7	185	150.8	167.6	190.8	155
Heating surface, total, sq. ft	2,526	3,582	2655.	3,194.	3245.4	2285.	2649.	2389.4	3307.8	2994.	3378.	2,355	3326.7	2735	2959.2	2005.7	2138.7	1,799
Heating surface, superheater, sq. ft	1,147*					480.		338.				460						365
Grate area, sq. ft	48	55.13	49.5	45″	53.5	43.5	49.5	44.8	54.9	32.1	94.8	49.5	54.93	34.8	46.27	81.6	87.54	33
Firebox, length	109⅝″	110¼″	108″	107″	108⅛″	96″	108″	96″	105⅛″	124″	126⅛″	108″	108⅛″	120″	102⅛″	122⅛″	126 3/16″	114″
Firebox, width	63¼″	72″	66″	60½″	71¼″	65¼″	66″	67¼″	75¼″	37¾″	108¾″	66½″	75¼″	41⅞″	65¼″	96¼″	100″	41⅞″
Fuel, kind	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil,	Anth. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Anth. coal	Anth. coal	Bit. coal
Tubes, number firetube	273	460	297	268	347	196	297	173	400	355	398	203	400	256	337	280	280	173
Tubes, number superheater						22		54				24						22
Tubes, diameter, firetube	2¼	2″	2″	2¼″	2″	2	2″	2″	2″	2″	2″	2″	2″	2¼″	2″	2″	2″	2″
Tubes, diameter, superheater						5⅜″		3½″				5″						5″
Tubes, length	14′ 6″	13′ 11⅝″	16′ 0″	19′	16′ 10″	16′	16′ 0″	16′ 0″	14′ 11″	15″	15′ 3″	16′	14′ 11″	17″	16′ 0″	12′ 6″	13′ 4¼″	13′ 9⅜″
Tender, coal capacity, tons	3,300G	13	10	10	14	9	10	12	12	2,940G	10	12½	12	10.5	10	12	10	4½
Tender, water capacity, gals	9,000	7,000	9,000	7,000	6,000	6,000	9,000	7,000	8,000	7,000	6,000	8,000	7,000	5,500	7,500	5,000	5,000	3,000
Weight on drivers ÷ tractive effort	4.72	5.18	4.53	4 75	4.27	4.05	4.48	4.20	5.10	4.37	4.38	4.38	4.77	4.58	4.38	4 80	4.22	4.80
Weight total ÷ tractive effort	9.71	8.97	8.60	9.20	8.10	7.95	8.35	7.90	6.70	5.57	5.72	5.99	6.27	6.27	5.80	6.95	6.40	8,40
T. E. × diam. drivers ÷ total H. S.	692.70	578.00	740.00	610.00	600.00	790.00	717.00	754.00	647.00	770.00	717.00	1024.00	647.00	705.00	655.00	800.00	765.00	753.00
Total heat. surf. ÷ grate area	52.2	64.97	53.80	70.50	60.50	52.30	53.60	53.30	60.20	93.00	35.60	47.50	60.50	78.50	64.00	24.70	24.40	71 00
Firebox heat. surf. ÷ total H. S., %	7.54	6 10	6.80	5.30	6.30	7.60	6.60	6.75	6.15	6.90	6.60	6.30	6.10	6.80	5.10	8.40	8.90	8.65
Wgt. on drivers ÷ total heat. surf.	44.76	37.10	41.50	33.10	32.60	43.80	39.60	44.80	51.00	53.40	45.60	61.50	44.50	49.00	45.75	55.30	46 80	57.40
Wgt. total ÷ total heat. surf.	92.32	64.60	78.90	64.00	61.80	79.50	74.00	80.00	67.00	68.00	59.80	81.10	58.70	67.00	60.50	80.50	71.00	100.00
Total H. S. ÷ superhtg. heat. surf.						4.76		7.08				5.10						4.92
Cylinder volume, cu. ft	8.3†	11.40	10.2†	9.†	10.40	10.40	10.20	10.40	11.40	12.30	10.90	17.20	11.40	10.20	10.40	8.60	9.50	9.50
Total heat. surf. ÷ cyl. vol	302.00	314 00	262.00	355.00	311.00	219.00	260.70	230.00	288.00	243.00	311.00	136.90	292.00	268.00	287.00	233.00	224.00	248.00
Sup. heat. surf. ÷ cyl. vol						46.20		32.50				26.70						38.42
Grate area ÷ cyl. vol	5.70	4.85	4.83	5.00	5.16	4.19	4.85	4.30	4.80	2.61	8.68	2.88	4.80	3.40	4 45	9.50	9.20	3.48
Reference in THE AMERICAN ENGINEER, year month page	1911 Feb. 44	1911 Apr. 126	1906 Aug. 308	1908 Jan. 37	1907 Dec. 471	1909 May 195	1905 May 154	1905 Sept. 329		1907 Dec. 481	1905 Nov. 407	1910 Feb. 64	1906 Feb. 59	1909 Feb. 52	1907 June 247			1910 Nov. 435

* Reheater Surface.

† Equivalant Simple Cylinders.